HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Environmental Impact Statement

F4 | Surface Water Quality Technical Report

Alpha Coal Project Surface Water Quality Technical Report

September 2010

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Glossary

Abbreviation	Definition
%	Percentage
Al	Aluminium
ALUM	Australian Land Use Management
ANC	Acid Neutralising Capacity
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	Arsenic
Ba	Barium
Bo	Boron
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
Cfu	Coliform Forming Units
Chl 'a'	Chlorophyll 'a'
Co	Cobalt
Cr	Chromium
Cu	Copper
DERM	Department of Environment Resource Management
DO	Dissolved Oxygen
EC	Electrical Conductivity
e.g.	Exempli gratia (for example)
Electrical Conductivity	Electrical conductivity or salinity are measures of the total concentration of inorganic ions (salts) in the water.
EPP	Environmental Protection Policy
ESCP	Erosion and Sediment Control Plan
Fe	Iron
GED	General Environmental Duty
GDR	Great Dividing Range
GIS	Geographic Information System
Hardness as CaCO3	Hardness is expressed in mg/L as CaCO3. Increasing calcium and magnesium in waters (hardness) is usually associated with increases in alkalinity. Changes in alkalinity will directly affect metal speciation.
Hg	Mercury
i.e.	Id est. (that is)
ISQG	Interim Sediment Quality Guideline
LCL	Lagoon Creek Lagoon
LCD	Lagoon Creek Downstream
LCU	Lagoon Creek Upstream
LCSRD	Lagoon Creek final SRD Discharge
Li	Lithium
LSCU	Little Sandy Creek upstream
Mn	Manganese

Abbreviation	Definition
MLA	Mining Lease Application
Mtpa	Million tonnes per annum
NCC	Native Companion Creek
NH^{4+}	Ammonium
Ni	Nickel
NO_2 and NO_3	Nitrite and nitrate
OC	Organochlorine Pesticides
OP	Organophosphorus Pesticides
Pb	Lead
Proponent	Hancock Prospecting Pty Ltd
QWQ	Queensland Water Quality
RCU	Rocky Creek upstream
REMP	Receiving Environment Monitoring Program
ROM	Run–of–mine
RP	Release Point
SMD	Slightly to Moderately Disturbed
SCU	Sandy Creek upstream
SPU	Spring Creek upstream
TP	Total Phosphorus
TN	Total Nitrogen
TPH	Total Petroleum Hydrocarbons
Tributary	A tributary is a stream which flows into another stream or river (a key stream).
TSS	Total Suspended Solids
Turbidity	The turbidity or 'muddiness' of water is caused by the presence of suspended particulate and colloidal matter consisting of suspended clay, silt, phytoplankton and detritus.
WM P	Water Management Plan
WQOs	Water Quality Objectives
Zn	Zinc

Executive summary

The Alpha Coal Project (the Project) comprises the development of thermal coal resources located approximately 170 kilometres (km) west of Emerald, and 56 km north–west of the town of Alpha in the Galilee Basin. The coal reserves for this Project exist within the mining lease application MLA 70426. The coal resources will be developed by open cut mining with related infrastructure. Coal will be mined at a rate of around 42 million tonnes per annum (Mtpa) run–of–mine (ROM) coal. The coal will be crushed, sized and washed, with product coal transported by rail to Abbot Point. The Project covers an area of approximately 33,706 hectares (ha) and will be developed by Hancock Prospecting Pty Ltd (HPPL).

The purpose of the surface water quality impact assessment is to describe the existing environment for water resources that may be affected by the Project Mining Lease Application (MLA) area in the context of environmental values as defined in such documents as the Environmental Protection Act 1994 (EP Act), Environmental Protection (Water) Policy 2009 (EPP(Water)), Australian New Zealand Environment and Conservation Council (ANZECC) 2000, and the Queensland Water Quality Guidelines (QWQG).

Five key streams have been identified within the study area, with all other streams located being tributaries of these key streams. Lagoon Creek is the most prominent watercourse in the study area, and it flows into the Belyando River, at about 100 km north of the Project area. The Belyando River catchment is part of the Burdekin Basin.

No Environmental Values (EVs) are attributed by official regulatory authorities to the watercourses within the MLA; therefore site-specific EVs for the receiving water were derived from a desktop analysis of available information on the watercourses located within the MLA and data on downstream water uses. The ecosystem condition that is most appropriate under the ANZECC guideline is a ‘slightly to moderately disturbed (SMD) system’. However because the creeks are ephemeral and the water quality differs under this type of flow regime, the Queensland Water Quality (QWQ) guidelines recommend the development of local separate guidelines rather than applying the default ANZECC values. As too few historical data on surface water quality were available for this assessment, no local values were derived. In addition, the available data quantity and sampling rationale did not allow for conclusions to be reached on the condition of the watercourses in the Project area. Consequently, a baseline monitoring program is detailed in this report and should be implemented within the next two years to collect:

- data from reference sites and derive local values for physio–chemical and biological parameters
- background data on all the creeks within the Project area to assess the creeks’ condition prior to the commencement of Project construction.

Water quality monitoring will continue throughout the Project life.

The potential impacts on water quality are associated with construction and operational activities in the Project area, vegetation clearing, creek diversions, and drainage of structures. Potential impacts from activities could be increased erosion and sedimentation, pollutants contaminating waterbodies, additional surface water, increased weed infestation, leaching of salts, metals and trace elements into ground and surface waters, and environmental incidents resulting from unregulated discharges of pollutants or polluted waters that do not meet water quality discharge standards into waterbodies.

Mitigation measures recommended relate to the implementation, monitoring and auditing of a Water Management Plan (WMP), an Erosion and Sediment Control Plan (ESCP), an Environmental Management System, and the effective management of water generated by the Project including water received as rainfall and/or water from underground seepage via the site Water Management System.

The implementation of the water quality monitoring programs detailed in this report should allow for an ongoing review of the performance of the various mitigation measures to protect the integrity of the receiving waterbodies. The program is designed to demonstrate that the mine’s operations on the Project area are not causing unacceptable environmental effects on surrounding watercourses and receiving waters, including stream ecological and physical process.

The on–going monitoring program will be revised once the results of the baseline monitoring program are available to ensure on–going monitoring using suitable site specific parameters.

Based on the recommended monitoring programs and mitigations measures given above, the residual impacts from the Project are predicted to be limited.

1. Introduction

The purpose of the surface water quality impact assessment is to describe the existing environment for surface water resources associated with the Alpha Coal Project's Mining Lease Application (MLA) area, and the potential impacts and proposed mitigation measures, in the context of environmental values as defined in such documents as the *Environmental Protection Act 1994* (EP Act), Environmental Protection (Water) Policy 2009 (EPP(Water)), Australian New Zealand Environment and Conservation Council (ANZECC) 2000, and the Queensland Water Quality Guidelines (QWQG).

2. Methodology of assessment

2.1 Methodology

The methodology of the surface water quality impact assessment for the Project area is outlined below.

Project description

The section provides a description of the features and activities of the Project that could impact on surface water quality. It outlines in particular the main water management strategies for the Project as described in the Alpha Coal Project Site water management system and water balance technical report.

Relevant legislation and guidelines

A review of relevant legislation, strategies, policies and guidelines with regards to surface water quality was undertaken. Relevant environmental values and associated trigger values for receiving waters were identified from a desktop analysis of the MLA land use, topography, creek characteristics and water usage of licence permit holders downstream of the Project area.

Existing environment

The existing environment within the study area was described using available meteorological data, land use information, geochemical characterisation of the overburden and interburden materials, as well as the description of the waterbodies likely to be impacted by the Project. The information for this review was collected from the Australian Bureau of Meteorology (BOM), Department of Environment and Resource Management (DERM), external reports and various maps using Geographic Information System (GIS).

Water quality data analysis

A desktop review was undertaken to identify available water quality data, this included a gap analysis and project specific water quality monitoring commissioning. Available water quality data was interpreted against the relevant trigger values for the identified environment values to describe existing water quality conditions.

A third party performed two surface water and sediment sampling surveys on the waterbodies of the Project area in 2009 and 2010. However, the data quantity and sampling rationale did not allow for conclusive assessment of the condition of the watercourses in comparison to recognised standard assessment methodologies, including the ANZECC (2000), and Queensland Water Quality Guidelines. Therefore, the Project specific data has not been presented in this technical report for assessment.

Due to the lack of available background data, water quality data from the closest DERM gauging station was collected. Native Companion Creek is a watercourse parallel to Lagoon Creek (see Figure 7.1). It flows into the Belyando River where it meets with Lagoon Creek's waters. The water quality of Native Companion Creek is considered comparable to the water quality of the creeks within the Project area, as they share similar characteristics, being upland freshwater streams above 150 m in elevation, ephemeral, are subject to similar surrounding land uses, and are in relatively close proximity to each other. Therefore Native Companion Creek was used as a reference for water quality in this report.

Potential impacts

Potential impacts of the Project activities on existing surface water quality values were identified using technical reports developed as part of the Volume 5, Appendix F of the Environmental Impact Statement (EIS).

Mitigation measures

Mitigation strategies and measures were described to manage the potential impacts of the Project on surface water quality. Interim discharge release limits were developed to protect environmental values.

Monitoring programs

A baseline and on-going monitoring program were developed in accordance with requirements outlined in the ANZECC (2000), Monitoring and Sampling Manual (2009), Queensland Water Quality Guidelines (2009) and relevant Australian standards.

Conclusion

The summary of key points of the surface water assessment, potential impact and proposed mitigation strategies.

Residual impacts

The description of the potential impacts of the Project following implementation of mitigation strategies and measures as outlined in this technical report.

3. Project description

The Alpha Coal Project (the Project) comprises the development of thermal coal resources situated 50 km north–west of the town of Alpha in the Barcaldine Regional Council in Central Queensland, as shown in Figure 3.1. The Project is located in the Galilee Basin which covers an area of 247,000 km^2. The coal reserves for this Project exist within the mining lease application (MLA) area MLA 70426 as shown in Figure 3.1 and Figure 3.2. The coal resources will be developed by open cut mining with related infrastructure. The Project covers an area of approximately 33,706 hectares (ha) and will be developed by Hancock Prospecting Pty Ltd as the Proponent of the Project.

The mining of the coal will be undertaken using a combination of truck, excavator, dozer, shovel, and dragline mining equipment. Coal will be mined at a rate of around 42 million tonnes per annum (Mtpa) run-of-mine (ROM) coal. The coal will be crushed, sized and washed before being transported by rail to Abbot Point for export.

The mine water management system is discussed in detail in the Water Management System and Water Balance technical report for the EIS (Volume 5, Appendix F). In summary, the water management system is designed to capture surface runoff which is affected by mine operations, and direct the water into either sediment runoff capture dams, environmental dams, or pit water dams. As much as practical, the mine water will be stored and reused on–site, depending on the water quality of the mine water.

There will be four types of water for the Project. These types are:

- clean water runoff from undisturbed catchments both upstream of, and within the MLA area. Clean water will be passed through the MLA area in defined drainage corridors/creek diversions/catch drains. Levees will be provided along creek diversions to help control flow and prevent flood waters entering the pit area. The design criterion for pit flood immunity is 3,000 year ARI storm event (equivalent to 1% chance of failure for the Project life). The design of creek diversions is described in the Flooding Technical Report (Volume 5, Appendix F)

- dirty water runoff from catchments disturbed by overburden management which is potentially affected by sediment only. Dirty water will be directed through Sediment Runoff Capture Dams (SRD) which in turn will be directed to the final SRD. Only the final SRD is designed to allow for controlled discharge into Lagoon Creek, assuming that water quality and quantity condition criteria are met:

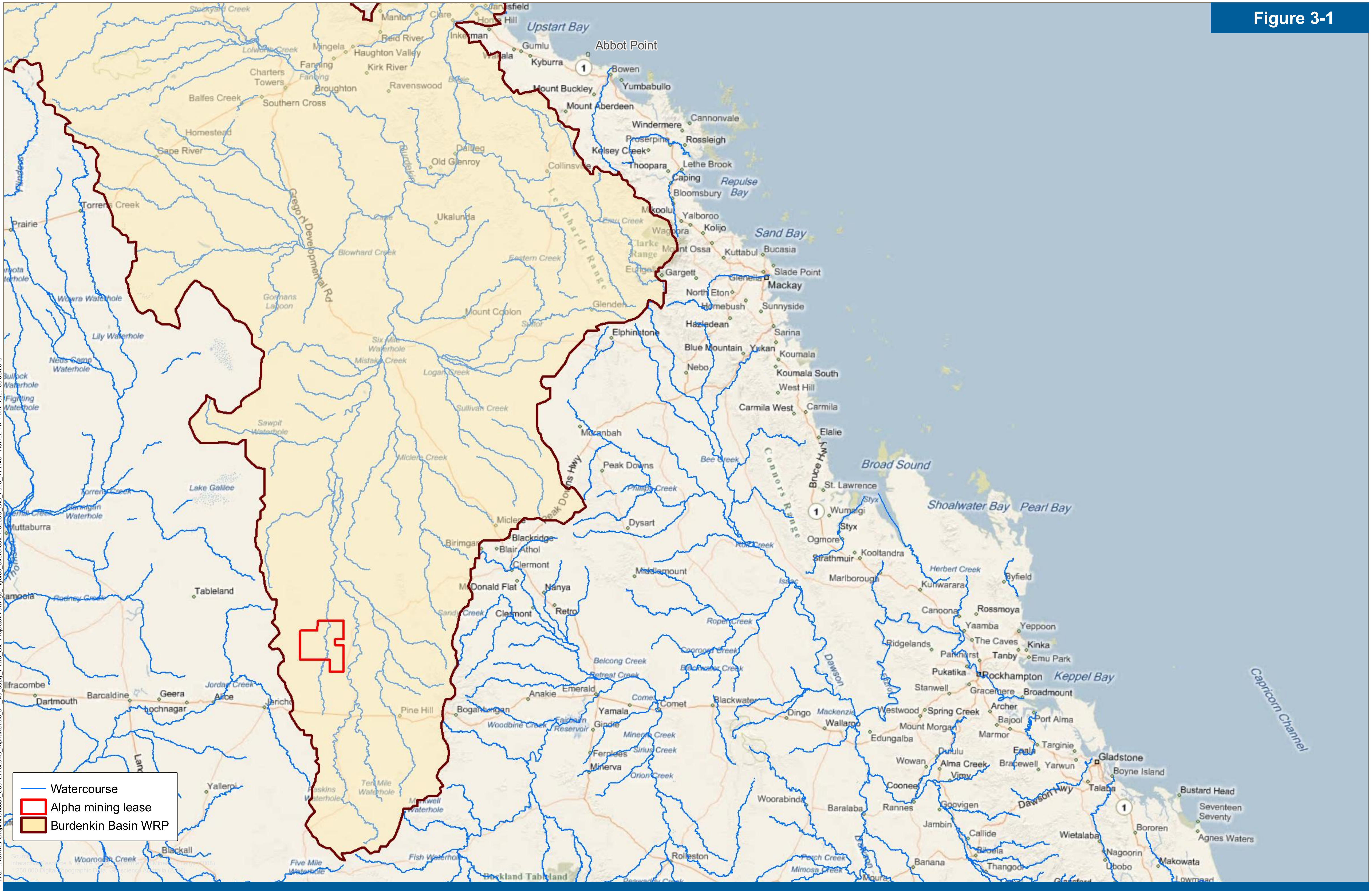
  - SRDs located on the eastern side of the overburden stockpile will be designed to discharge into the drainage channel located on the western side of the mine pit levee to the final SRD located at the northern end of the mine site, from where controlled releases may occur

  - SRDs located on the western side of the overburden stockpile will discharge via gravity or pumping to the eastern SRDs. In extreme rainfall events, western SRDs will spill/overtop into the associated pit.

- contaminated runoff from the mine industrial area (MIA), ROM pads, and from in–pit which is potentially affected by various contaminants from mining operations. Contaminated water will be directed to environmental dams and pit water dams, for storage and reuse during mine operations

- raw water and process water for the Coal Handling and Process Plant (CHPP). Raw water will be sourced off–site and stored in the raw water dam. Process water will be recycled in a closed loop system to the tailings dam and tailings decant dam. Neither raw or process waters will be discharged from the MLA area as part of the site water management system, and therefore are not considered further in the water quality technical report.

Figure 3-1



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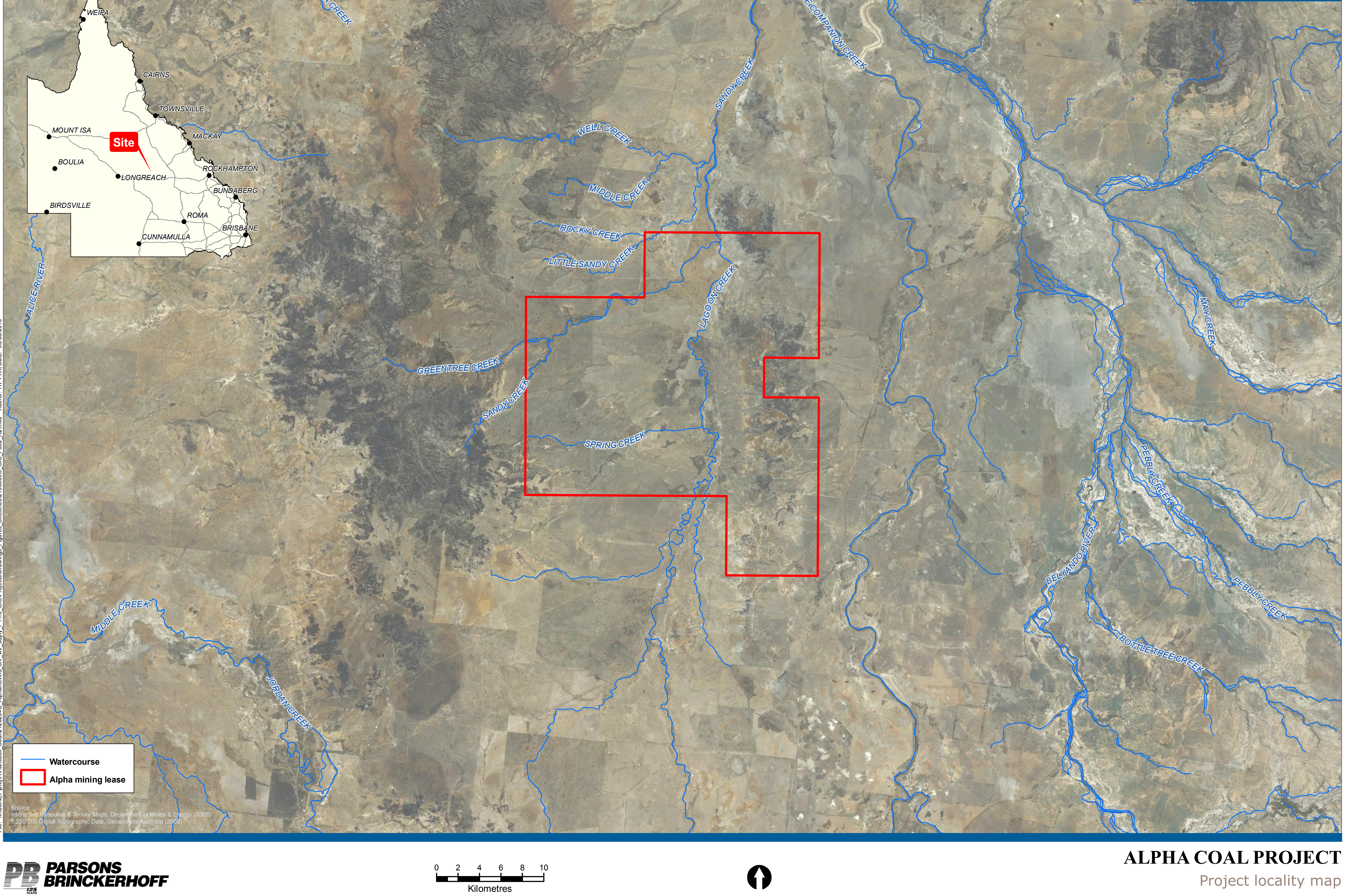
ALPHA COAL PROJECT

Project location

Figure 3-2



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ALPHA COAL PROJECT

Project locality map

4. Relevant legislation and guidelines

4.1 Current legislation

The Environmental Protection (Water) Policy 2009 (EPP Water) is subordinate legislation under the *Environmental Protection Act 1994* that functions as an important tool for ensuring that the broad environmental protection measures are better defined for the protection of waterbodies.

The EPP Water states legally binding standards for water quality. Environmental Values (EVs) and Water Quality Objectives (WQOs) for surface water have been established under Schedule 1 of the EPP Water.

None of the watercourses associated with the Project are listed in Schedule 1 of the EPP Water, or the corresponding EVs and WQOs report(s). The EVs of the receiving waters are therefore deemed to be considered by addressing water quality guidelines. These water quality guidelines are quantitative measures or statements for indicators that protect a stated EV (Section 7(2), EPP Water). The following documents are used to decide the water quality guidelines for an EV for water (Section 7(3), EPP Water):

a) site specific documents

b) the Queensland Water Quality (QWQ) guidelines

c) the Australian water quality guidelines

d) other documents published by a recognised entity.

To the extent of any inconsistency between the documents mentioned above for a particular water quality type, the documents will be used in the order in which they are listed (Section 7(4) EPP Water).

The EVs of waters to be enhanced or protected under the EPP Water are:

- biological integrity of a high ecological value waters, slightly disturbed waters, moderately disturbed water and for highly disturbed waters
- suitability for recreational or aesthetic use
- suitability for supply as drinking water
- suitability for primary industry
- suitability for industrial use
- cultural and spiritual values of the water.

The EPP Water defines an indicator for an EV as a property that is able to be measured or decided in a quantitative way. WQOs are generally developed based on the review of the available site specific information that pertains to the associated EV. The EPP Water states for waterbodies not mentioned in its Schedule 1, the Queensland Water Quality Guidelines (QWQG) and Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines are appropriate to be used to decide water quality trigger values for EV indicators.

4.2 Site based environmental values

Environmental values for the section of the Burdekin catchment where the Project is located have not been specified the Schedule 1 of the EPP Water 2009. The Barcaldine Regional Council confirms that there are no declared EVs for the area (Rob Bauer, Executive Manager, Barcaldine Council, pers. Comm. 28.06.10).

As no environmental values have been identified by official regulatory bodies, environmental values for the project area for the receiving waters were derived from a desktop analysis of available information on the watercourses located within the MLA and data on downstream water uses:

- protection of aquatic ecosystems
- suitability for recreational use and aesthetics, including fishing activities
- cultural and spiritual values. For further information on these values, refer to the Cultural Heritage reports in EIS Volume 2, Sections 18 and 19
- suitability for primary industrial uses, including irrigation and stock drinking water. Refer to Section 6.3 Land use for further discussion.

4.3 Applicable guidelines

Guidelines provide trigger values designed to protect environmental values (EVs). Where site specific information is not available, the QWQG and ANZECC 2000 guidelines are used as a general tool for assessing water quality and are the key to determining water quality objectives that protect and support the designated environmental values of water resources, and against which performance can be measured.

4.3.1 Regional and subregional guideline identification

QWQG provide a mechanism to tailor guidelines to better address the natural regional and local variability in water quality across the state. The QWQG takes a regional approach with a regional guidelines framework within Queensland as well as sub–regional (local) guidelines within Queensland regions. These are defined as:

- regional guidelines based on a set of major biogeographic regions that have been defined for Queensland – Gulf, Lake Eyre, Murray Darling and east coast (South–east, Central coast, Wet tropic, Eastern Cape). Most water types are common across all regions but there may be a few types specific to a particular region
- sub–regional (local) guidelines developed where sufficient spatially detailed data is available.

The watercourses passing through the Project area are part of the Central Coast Region and Burderkin Basin (Figures 2.3.1 and 2.3.2, Section 2.3.1, QWQG 2009). The watercourses are defined as upland freshwater, hence ANZECC 2000 guidelines water must be adopted (Section 2.4, Table 2.4.1 QWQG 2009).

The Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines ‘are used as a general tool for assessing water quality and are the key to determining WQOs that protect and support the designated EVs of water resources, and against which performance can be measured’ (ANZECC 2000, p 2.9).

Ephemeral streams have short–lived high flows, almost no baseflow, and long periods of nil flow. However, both the ANZECC and the QWQG guidelines are largely based on data collected during baseflow (ambient) periods. These guidelines are generally appropriate in estuarine and marine waters and for freshwaters under baseflow conditions. However, issues arise when guidelines derived in baseflow periods are applied to high flow or nil flow periods, because water quality at these times is naturally different. The more ephemeral the stream, the more significant this issue becomes.

As water quality differs under ephemeral flow regimes and because there is not sufficient information to characterise the water quality requirements of ephemeral systems, the QWQG recommend the development of local guidelines for specific ephemeral streams. One way to address this issue is to collect water quality data from reference streams during flood periods or nil flow periods and use this data to derive guidelines that can be applied to the assessment of stream conditions.

The Department of Environment and Resource Management (DERM) confirmed this requirement and recommended collection of data from reference sites and historical data from the watercourses affected by the Project prior to commencement of any mine activities (Andrew Moss, Environment and Resource Sciences, Queensland Department of Environment and Resource Management, pers. comm. 30.06.10).

As Schedule 1 of the EPP Water does not define water quality guidelines relevant to the Project area, QWQG and ANZECC trigger values will be used in this report as reference when compared against collected data.

4.3.2 Burdekin Basin Water Resource Plan

The water resources that pertain to the Project area are regulated through the Burdekin Basin Water Resource Plan 2007 (WRP).

As specified in Part 1, Section 2 of the WRP, the purpose of the plan is to:

- define the availability of water in the plan area
- provide a framework for sustainably managing water and the taking of water
- identify priorities and mechanisms for dealing with future water requirements
- provide a framework for establishing water allocations
- provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems
- regulate the taking of overland flow water.

The WRP is implemented through the Burdekin Basin Resource Operation Plan (2009) (ROP). The ROP indicates that the sole water allocation operation licence in Belyando Suttor region is at the Burdekin Falls Dam and attributed to Sunwater Limited.

This water resource is located at about 350–400 km from the MLA and is not likely to be impacted by the mine activities.

The ROP defines the rules that guide the daily management of stream flows and water infrastructure to achieve the objectives of WRP.

5. ANZECC derived water quality values

5.1 Level of aquatic ecosystem condition

ANZECC 2000 (Section 3.1.3.1) distinguishes three levels of aquatic ecosystem conditions:

1. High conservation/ecological value systems (HEV) — effectively unmodified or other highly–valued ecosystems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations. While there are no aquatic ecosystems in Australia and New Zealand that are entirely without some human influence, the ecological integrity of high conservation/ecological value systems is regarded as intact.

2. Slightly to moderately disturbed systems (SMD) — ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation; marine systems would have largely intact habitats and associated biological communities. Slightly– moderately disturbed systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoral activities, or marine ecosystems lying immediately adjacent to metropolitan areas.

3. Highly disturbed systems (HD) — measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture.

The ecosystem condition that is considered to be most appropriate for the receiving waters in the vicinity of Project, is **'slightly to moderately disturbed system'–**— a discussion regarding the suitability of the ecosystem category is provided in Section 7.1.3 Water quality findings of this report.

5.2 Trigger values

Trigger values were developed for the identified environment values using ANZECC default values for freshwater species with a 95% level of protection, except for toxicants for which the ANZECC guideline recommends the 99^{th} level of protection for specific parameters. These values are considered appropriate to assess slightly to moderately disturbed ecosystems such as those encountered in an area used for stock grazing. The ANZECC guidelines indicate that it is appropriate to compare dissolved concentrations of metals to the trigger values. ANZECC (2000) trigger values were selected for physical and chemical stressors, toxicants and sediment based on the known and potential impacts of coal mining projects. These are outlined below. For biological stressors, refer to the Volume 5, Appendix E, Aquatic Ecology Technical Report.

5.2.1 Physical and chemical stressors

For physical and chemical stressors the ANZECC (2000) guidelines distinguish between six categories of ecosystems – estuarine, coastal and marine, lakes and reservoirs, wetlands, upland rivers, and streams and lowland rivers and streams.

All streams in the MLA were identified as upland freshwater streams. Upland streams are defined in QWQ guidelines 2009 and ANZECC 2000 as those >150 m in elevation. Three lagoons along Lagoon Creek were identified as wetlands using WetlandMaps 2.0 (map 8151 Edwinstowe, Wetland Info website, DERM, 2010).

Using the default ANZECC approach for regionalisation, the MLA area sits in the Tropical Australia region which includes:

- northern Western Australia
- Northern Territory
- northern Queensland.

Table 5.1 specifies trigger values applicable to waterways in Tropical Australia under the associated ecosystem type including upland rivers and wetlands.

Whilst four environmental values have been identified (aquatic ecosystems, recreation and aesthetics, cultural and spiritual values and primary industrial uses) aquatic ecosystem triggers are the most stringent and therefore, they form the basis for the trigger values presented in Table 5.1.

For biological stressors, refer to Volume 5, Appendix E, Aquatic Ecology Technical Report.

Table 5.1 Physical and chemical trigger values

Parameters	Unit	Limit	Upland river	Wetland
Chlorophyll a (Chl a)	µg/L		na	10
Total phosphorus (TP)	µg/L		10	10
Filterable reactive phosphate (FRP)	µg/L		5	5
Total nitrogen (TN)	µg/L		150	350
Oxides of nitrogen (NOx)	µg/L		30	10
Ammonium (NH4+)	µg/L		6	10
Dissolved Oxygen (DO)	% saturation	Lower Limit	90	90
	% saturation	Upper Limit	120	120
Electrical Conductivity	µS/cm	Lower limit	20	90
	µS/cm	Upper Limit	250	900
Turbidity	NTU	Lower limit	2	2
	NTU	Upper Limit	90	200
pH	n/a	Lower Limit	6.0	6
	n/a	Upper Limit	7.5	9

na = not applicable

(Source: ANZECC 2000, p. 3.3–12,13)

5.2.2 Toxicants

For toxicant stressors the ANZECC (2000) guidelines distinguish between two categories of ecosystems – freshwater and marine. Only parameters for freshwater ecosystem are relevant to the waterbodies within the Project area.

Relevant trigger values for the Project are outlined in Table 5.2. Similar to physical and chemical stressors, aquatic ecosystem triggers are the most stringent of the environmental values, and therefore form the basis for values in Table 5.2.

The selection of the trigger values in Table 5.2 was based on the report ‘A study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin’ published by the Queensland government in 2009. The study focuses on discharges from coal mining operations as the Fitzroy River Basin’s large–scale mining activities are dominated by coal mining and planned coal mine expansions. Consequently, parameters selected by the DERM in this study are particularly relevant to this report.

The establishment of local trigger values, as discussed in the Section 8.1, will be tailored according to the collected background information and the expected mine activities.

Table 5.2 Toxicant trigger values

Group	Parameters	Unit	ANZECC freshwater trigger values	Level of protection
Dissolved Metals and Metalloids	Aluminium	(mg/L)	0.055 (pH>6.5) NE (pH<6.5)	95%
	Arsenic	(mg/L)	0.024	95%
	Boron	(mg/L)	0.37	95%
	Cadmium	(mg/L)	0.0002	95%
	Chromium	(mg/L)	0.001	95%
	Cobalt	(mg/L)	NE	na
	Copper	(mg/L)	0.0014	95%
	Iron	(mg/L)	NE	na
	Lead	(mg/L)	0.0034	95%
	Manganese	(mg/L)	1.9	95%
	Mercury	(µg/L)	0.06	99%
	Molybdenum	(mg/L)	NE	na
	Nickel	(mg/L)	0.011	95%
	Silver	(µg/L)	0.005	95%
	Selenium	(mg/L)	0.005	99%
	Vanadium	(mg/L)	NE	na
	Uranium	(mg/L)	NE	na
	Zinc	(mg/L)	0.008	95%
Inorganics	Sulphate	(mg/L)	1000*	na
	Fluoride	(mg/L)	1000*	na
	Nitrate	(mg/L)	0.7	95%
	Ammonia	(mg/L)	0.9	95%
Generic	Oil and petroleum hydrocarbons	(mg/L)	NE	na

na: not applicable NE: Not Establish LL: Lower Limit UL: Upper Limit

*: livestock drinking water protection

Trigger values outlined in the ANZECC 2000 Guidelines for 95% and 99% level of protection for freshwater species (see Table 5.2 above) are soft water trigger values. Table 5.3 below summarises the conversion factors that should be applied at each sampling event to determine an appropriate specific trigger value for selected metals depending on the hardness of the water (adopted from Table 3.4.4 ANZECC (2000) Guidelines).

Table 5.3 Approximate factors to apply to soft water trigger values for selected metals in freshwaters of varying hardness

Category	Hardness (mg/L of $CaCO_3$)	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Soft (0 – 59)	30	No adjustment – use trigger values in Table 5.2 above					
Moderate (60 – 119)	90	X 2.7	X 2.5	X 2.5	X 4.0	X 2.5	X 2.5
Hard (120 – 179)	150	X 4.2	X 3.7	X 3.9	X 7.6	X 3.9	X 3.9
Very hard (180 – 240)	210	X 5.7	X 4.9	X 5.2	X 11.8	X 5.2	X 5.2
Extremely hard (400)	400	X 10.0	X 8.4	X 9.0	X 26.7	X 9.0	X 9.0

5.2.3 Sediments

For sediments, the ANZECC (2000) guidelines make no distinction between various categories of freshwater and hence nor between upland freshwaters and wetlands. Total load and fate of contaminants, particularly to enclosed systems, should be considered. Sediments are important, both as a source and as a sink of dissolved contaminants.

As well as influencing surface water quality, sediments represent a source of bioavailable contaminants to benthic biota and hence potentially to the aquatic food chain. Table 5.4 specify the recommended sediment quality guideline values that are relevant to the watercourses within the MLA area.

Table 5.4 Sediment quality trigger values

Group	Parameters	Unit	Interim sediment quality guideline (ISQG) – Low	Interim sediment quality guideline (ISQG) – High
Metals	Antimony	(mg/kg dry wet)	2	25
	Arsenic	(mg/kg dry wet)	20	70
	Cadmium	(mg/kg dry wet)	1.5	10
	Chromium	(mg/kg dry wet)	80	370
	Copper	(mg/kg dry wet)	65	270
	Lead	(mg/kg dry wet)	50	220
	Mercury	(mg/kg dry wet)	0.15	1
	Nickel	(mg/kg dry wet)	21	52
	Silver	(mg/kg dry wet)	1	3.7
	Zinc	(mg/kg dry wet)	200	410
	Lindane	(µg/kg dry wet)	0.02	8
	Total polychlorinated biphenyls	(µg/kg dry wet)	23	NE

NE: Not Establish

6. Existing environment

6.1 Meteorology

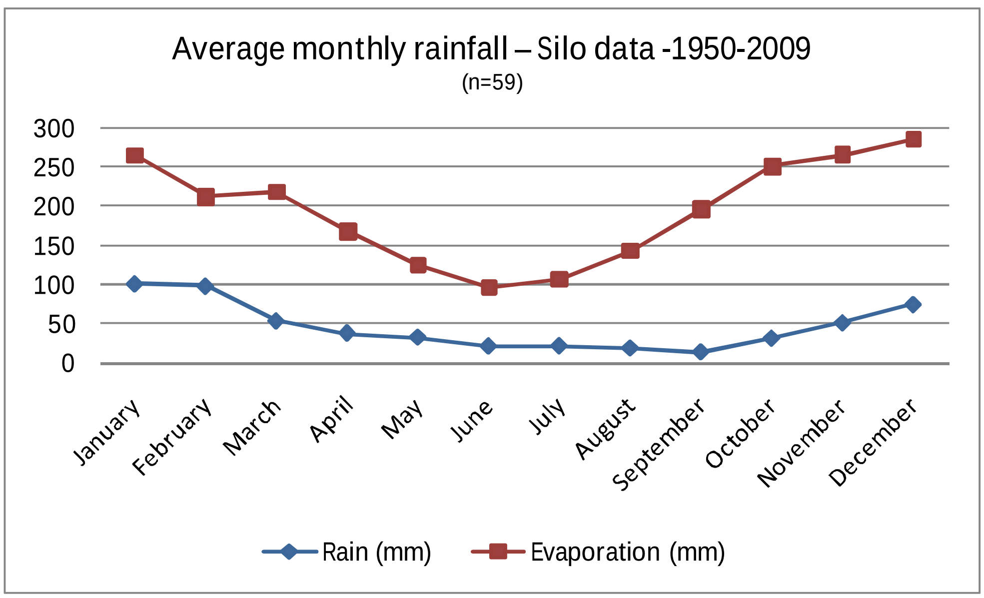
Historical daily rainfall and evaporation data was obtained for the region using the DERM Silo Data Drill facility. The Data Drill accesses grids of data interpolated from surrounding Bureau of Meteorology point observations. The interpolations are calculated by splining and kriging techniques. The key advantage of using the Data Drill is that rainfall and other climate data can be derived for any location throughout Australia, the data is continuous and can be provided for an extended period of 100 years or more.

Averaged monthly Silo data for the period 1950 to 2009 is shown in Figure 6.1 (silo number 20100531, Data Drill) and averaged monthly rainfall data for the period from 1886 to 2010 from the Bureau of Meteorology is shown in Figure 6.2 (station 036007 Barcaldine post office).

The data indicates that:

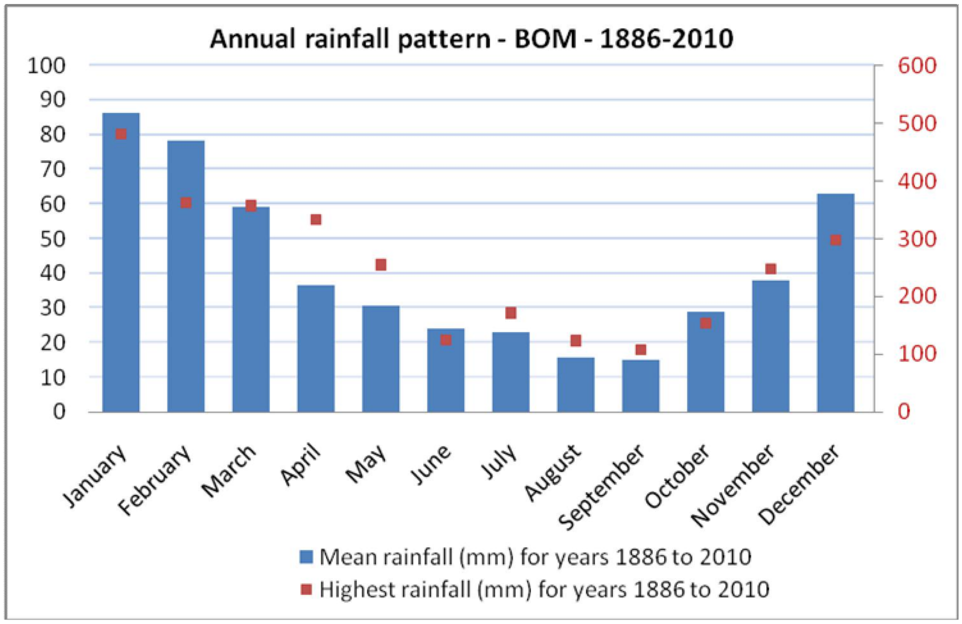
- average annual rainfall at the Project area is 535 mm (silo data)/500 mm (Bureau of Meteorology) and is highest in the wet season months between November and February and lowest during the dry months of winter.

Mean number of days of rain above 1 mm is 40 days annually (Bureau of Meteorology).



(Source: Data Drill, DERM, July 2010)

Figure 6.1 Average monthly rainfall – Data drill



(Source: Climate statistics for Australian locations, Bureau of Meteorology, July 2010)

Figure 6.2 Average monthly rainfall – Bureau of Meteorology (BOM)

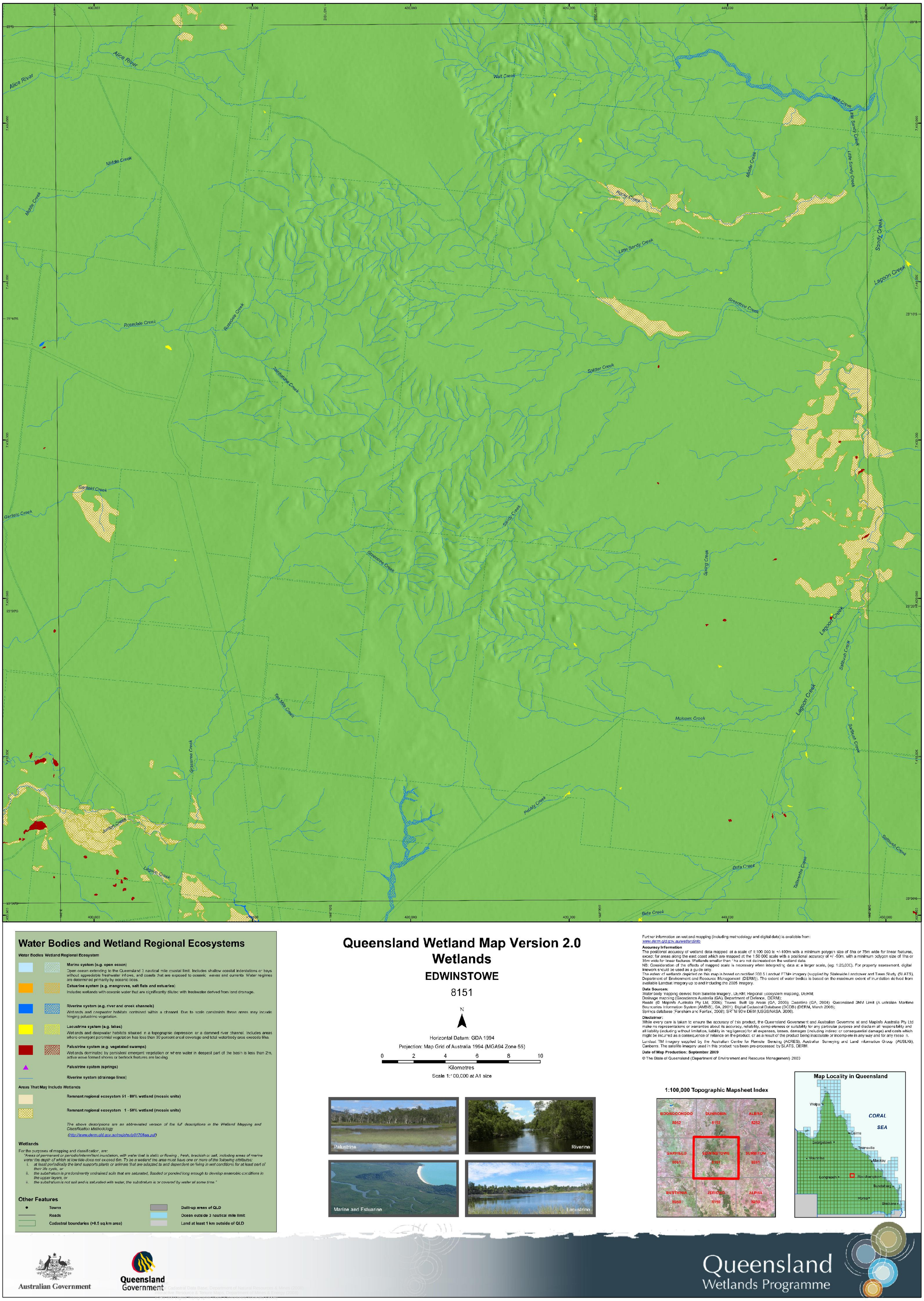
6.2 Water resource

The Project area, defined as MLA 70426, consists of flat terrain which slopes gently from an elevation of 400 m in the south–west to approximately 300 m along Lagoon Creek and rises again to 375 m to the east.

Five key streams have been identified within or immediately adjacent to the Project area (Figure 6.4) and as part of the Burdekin Basin. All other streams located within the Project area are tributaries of these key streams. Lagoon Creek is the most prominent watercourse in the Project area, and it flows into the Belyando River, at about 100 km north of the Project area. The Belyando River continues to the north joining with the Suttor River and eventually the Burdekin River at Lake Dalrymple (Burdekin Falls Dam).

The main characteristics of key streams are summarised in Table 6.1, with the stream length, water type and flow characteristic. All the streams were identified as upland freshwater creek (>150 m as defined in QWQ guidelines 2009 and ANZECC 2000) and reported as ephemeral streams. See Figure 6.5 for information on the Project area topography.

Three wetlands along Lagoon Creek were identified using WetlandMaps 2.0, see Figure 6.3 (map 8151 Edwinstowe, Wetland Info website, DERM, 2010) however only one wetland – Murdering Lagoon – was reported as a permanent water feature.



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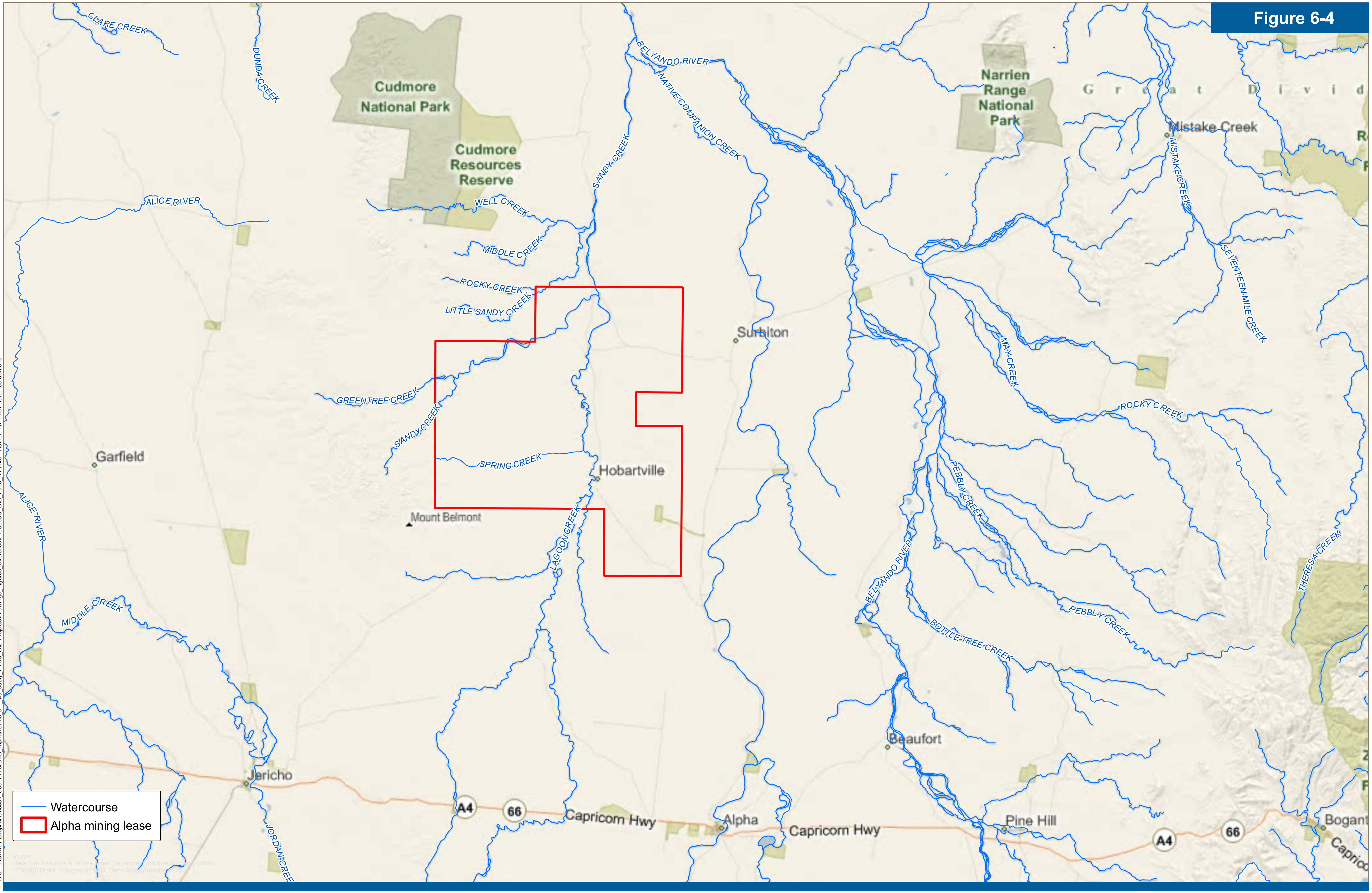

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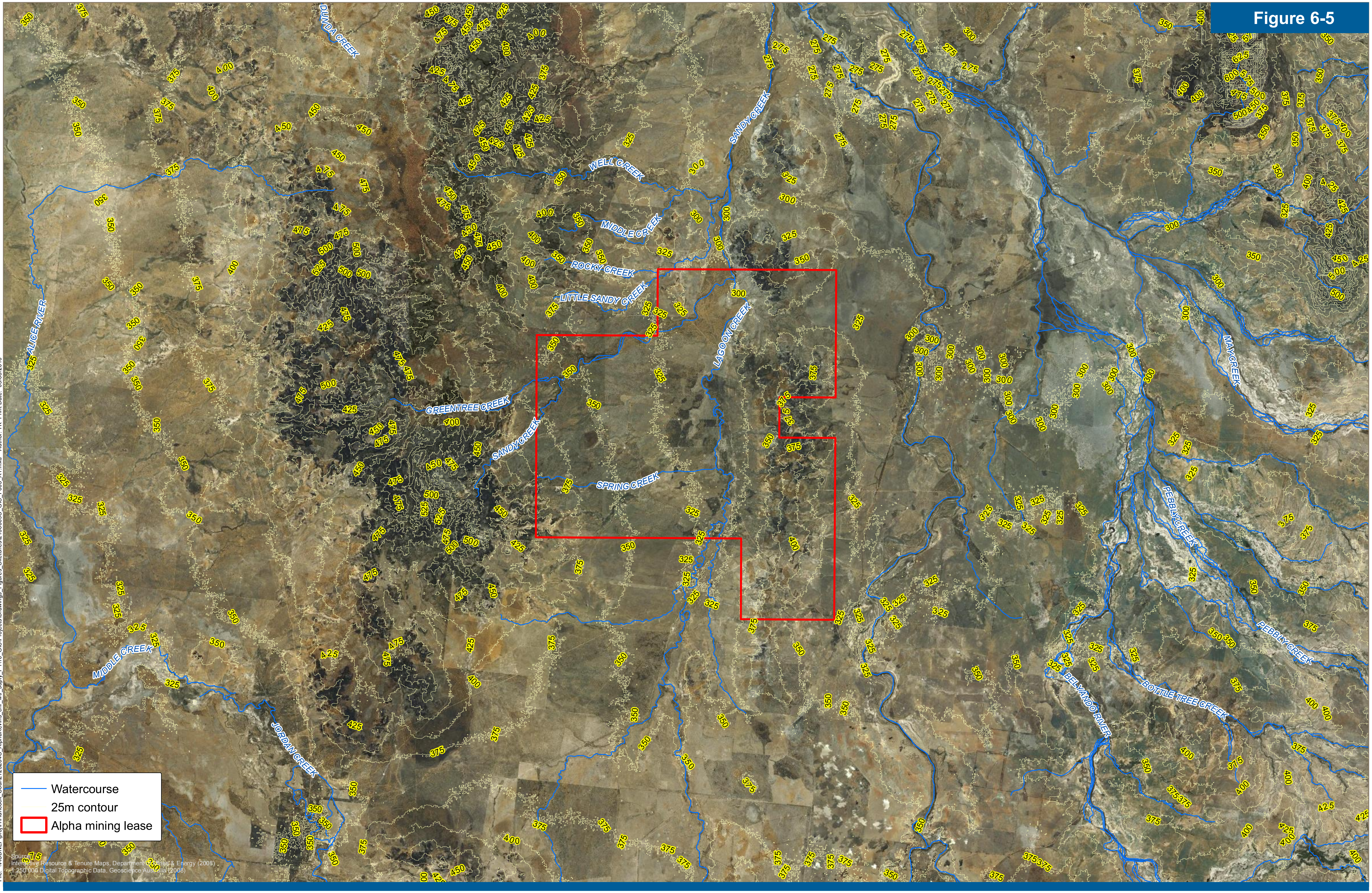
Major site catchments

Figure 6-5



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0 2 4 6 8 10
Kilometres

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Major site catchments topography

Table 6.1 Key stream characteristics

Stream	Altitude	Order	Stream length (km)	Classification	Water type	Ecosystem	Flow
Rocky Creek	300 to 400 m	2nd	~30	Defined watercourse	Upland freshwater	Slightly to moderately disturbed	Ephemeral
Little Sandy Creek	300 to 375 m	2nd	~30	Defined watercourse	Upland freshwater	Slightly to moderately disturbed	Ephemeral
Sandy Creek	300 to 450 m	2nd	~50	Defined watercourse	Upland freshwater	Slightly to moderately disturbed	Ephemeral
Spring Creek	300 to 350 m	2nd	~5	Defined watercourse	Upland freshwater	Slightly to moderately disturbed	Ephemeral
Lagoon Creek	275 to 400 m	3rd	~120	Defined watercourse	Upland freshwater	Slightly to moderately disturbed	Ephemeral

6.3 Land use

Existing land use in the surroundings of the Project area is illustrated in the Figure 6.6, and in EIS Volume 2, section 6.

Land surrounding of the Project area is classified 2.1.0 – Grazing natural vegetation under the Australian Land Use Management (ALUM) system. The land has been disturbed by low intensity cattle grazing on native vegetation, local transport along Degulla Road and Hobartville Road and coal exploration drilling (Liam Baldirson, Land Use officer, Barcaldine Council – pers. comm.03.08.2010)

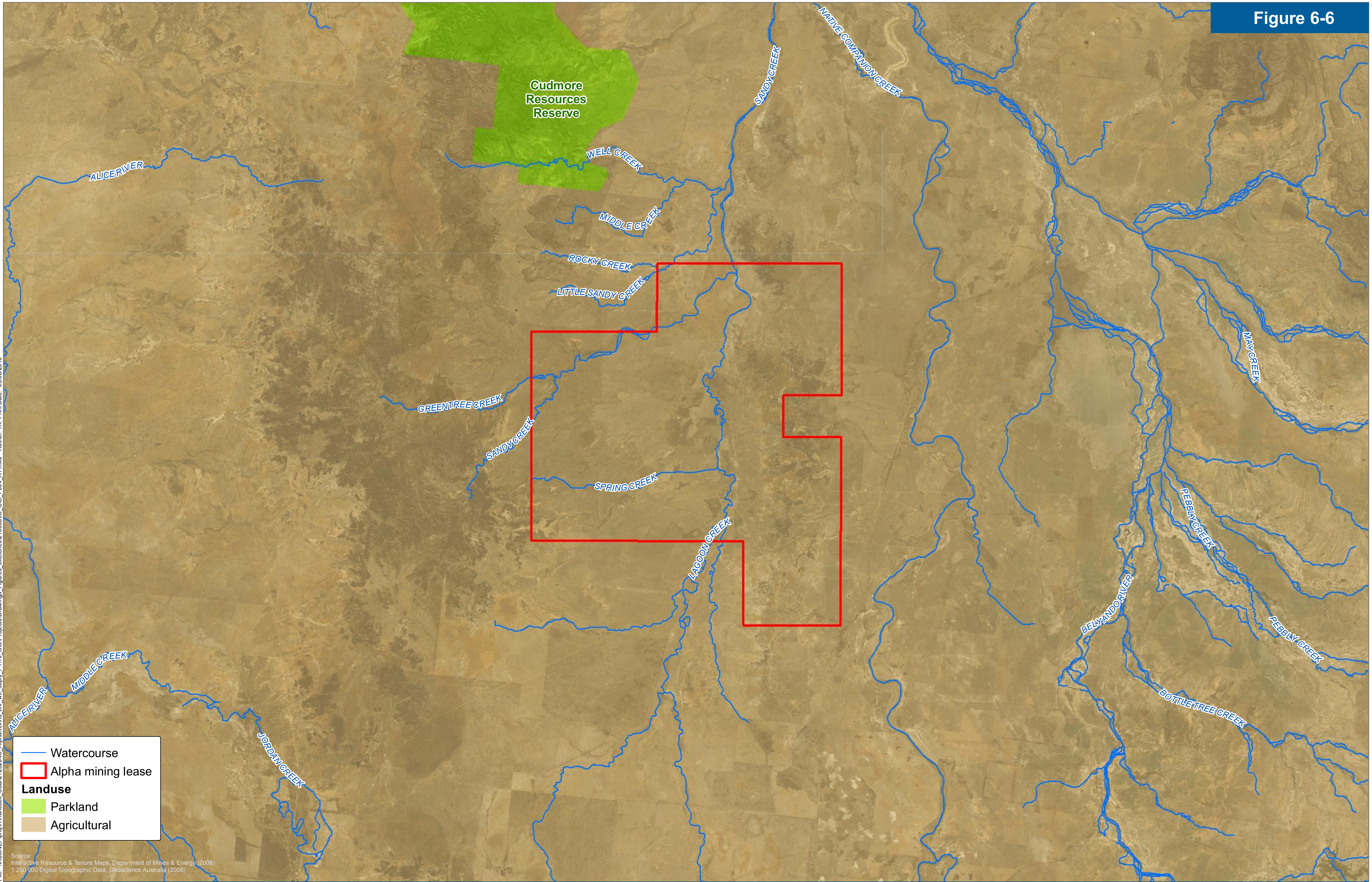
The current land use in close proximity of the creeks within the Project area confirms that the ecosystem condition that is most appropriate to be applied to the watercourses, is ‘slightly to moderately disturbed system’. In addition, as identified in the Cultural Heritage technical report, evidence suggested that the Murdering lagoon had been dredged in the 1980’s and since used for cattle grazing. Therefore the lagoon is also classified as ‘slightly to moderately disturbed’ ecosystem in agreement with the ANZECC (2000) guidelines definition.

According to the Burdekin Resource Operation Plan 2009 (ROP), there are currently no surface water license holders along the section of the watercourses in the Project area.

Only one water licence holder (licence number: 48434F) was identified considerably downstream of Lagoon Creek at about 250–300 km of the Project area along with several water licence holders on streams parallel to Lagoon Creek.

These licences holders are not likely to be impacted by the Project as they are not located directly downstream of the MLA. Please refer to Figure 6.7 and Table 6.2 for more details.

Figure 6-6



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0 2 4 6 8 10
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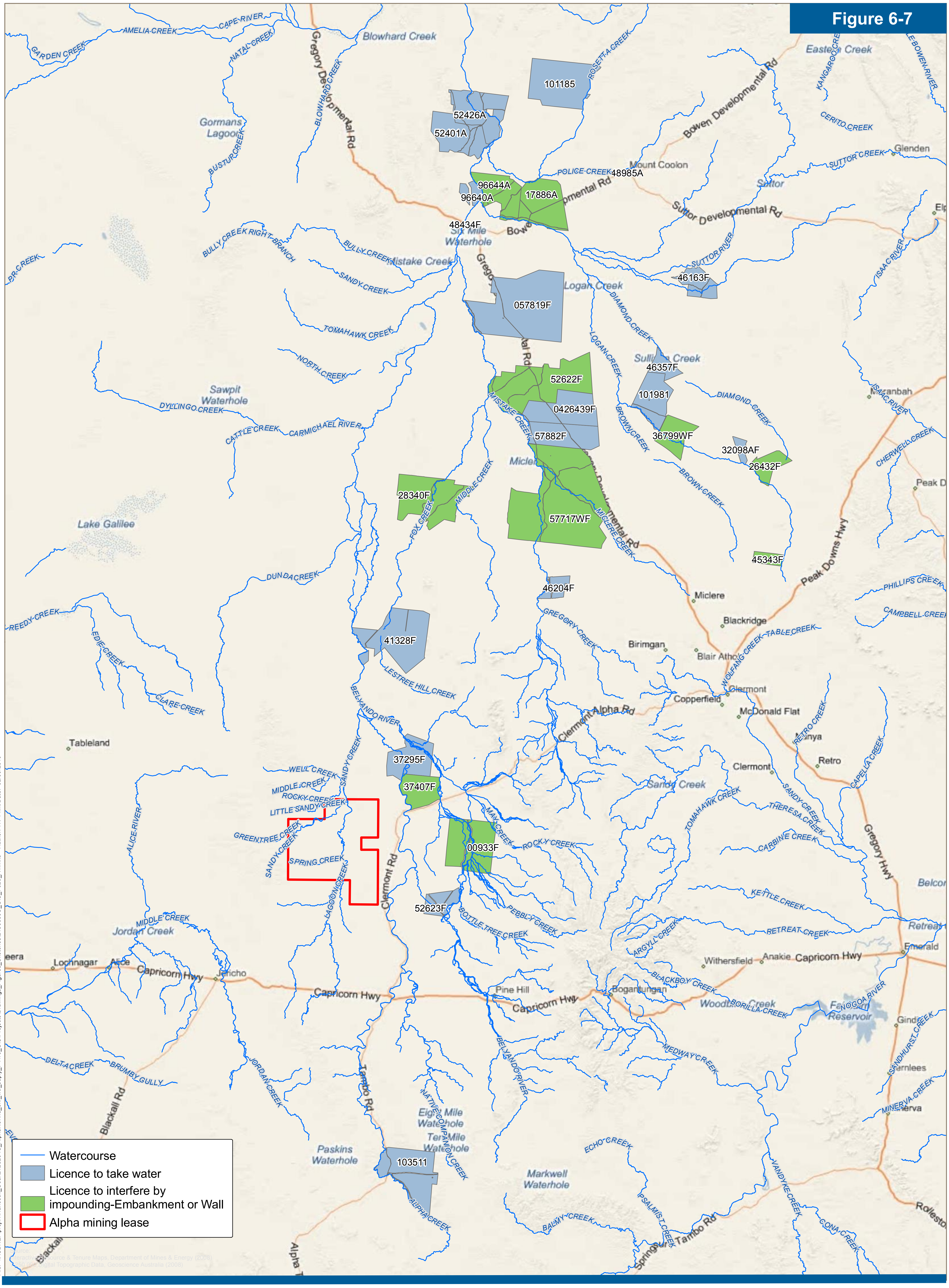
Land use



0 10 20 30 40 50
Kilometres

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Licence permit holders

Table 6.2 Permit licence holders

Licence number	Licence type	Licensee	Purpose	Watercourse
00933F	Licence to interfere by impounding-Embankment or Wall	KM & WD Appleton	Impound Water	Belyando River
52623F	Licence to take water	GD & JM Hoch	Water harvesting	Belyando River
48434F	Licence to take water	Koch & Co Pty Ltd	Domestic Supply	Belyando River
37295F	Licence to take water	RH & WTC Rostron	Stock	UT Belyando River
41328F	Licence to take water	EI, GE, & GJ Salmond & Ors	Stock	Fox Creek
28340F	Licence to interfere by impounding-Embankment or Wall	TJ & WG Dennis	Impound Water	Fox Creek
37407F	Licence to interfere by impounding-Embankment or Wall	JE & EJ Goodwin and N K Thompson	Impound Water	Belyando River (anabranch)
103511	Licence to take water	CD & LE Hewitt	Water harvesting	Alpha Creek

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6.4 Geochemical characterisation

A geochemical characterisation of the Project area was performed in 2010, as discussed in Appendix J of Volume 5 of the EIS. Overburden and interburden material was assessed for potential:

- acid and metalliferous drainage
- release of salinity
- presence of dispersive/erosive materials.

A 450,000 tonne bulk sample test pit of coal has been approved from which samples of overburden and interburden were taken. The geochemical characteristics of the materials present at the bulk sample site are presented in Table 6.3 below.

Table 6.3 Geochemical characteristics

Material characteristic	Overburden	Coal and coal waste
Acid forming potential	Non–acid forming (94%)	Potentially acid forming
Sulphur content	Very low and excess Acid Neutralising Capacity (ANC)	Total sulphur 0.5–0.6% and low ANC
Risk of acid generation	Very low	Elevated
pH	6–7, some clays 5–6	Natural 6–7 and some roof/floor at 4–5
Salinity	Low in sandstone and elevated in some clays	Low to moderate but potential to increase
Potential for metal enrichment and metal sparingly soluble	No metal enrichment and metal sparingly soluble	No metal enrichment and metal sparingly soluble at neutral pH
Water classification	Extracts within Australian drinking water standards and pH target	Extracts within Australian drinking water standards and pH target
Dispersive/non dispersive material	Mixture of both	Typically non–dispersive

7. Water quality data analysis

7.1 Water data analysis

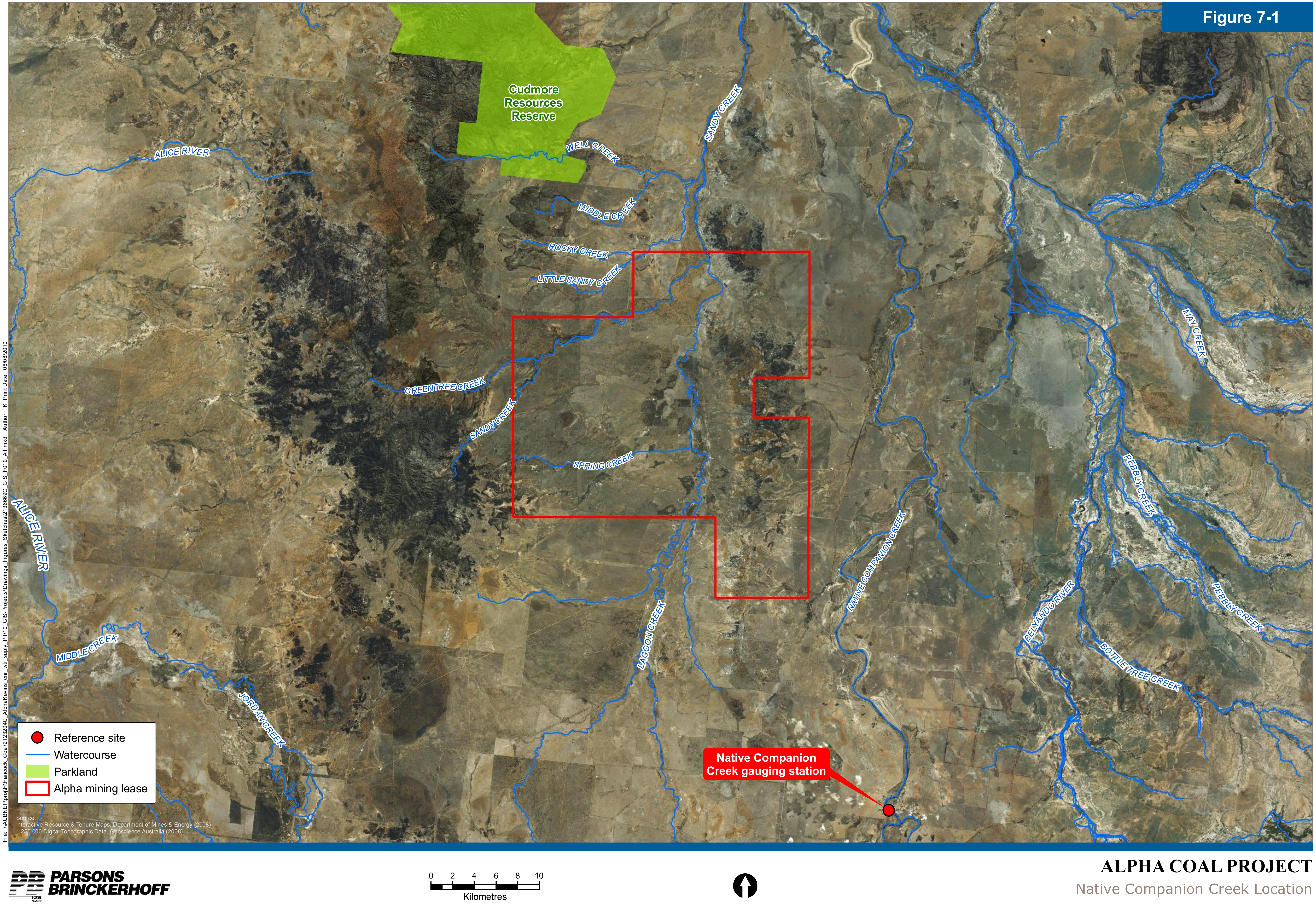
7.1.1 Historical data of the WaterShed

WaterShed is a surface water data archive developed by the Department of Environment and Resource Management (DERM). The department collects and manages data on the quantity and quality of fresh water in the state's streams and aquifers, as the basis for water resource planning and water management activities. The data available includes gauging station information, streamflow data summaries and results of chemical analysis of water samples.

- Flow summary information is based on data recorded and calculated by the DERM's hydrographic staff.
- Water quality information is based on chemical analysis of samples collected by DERM's hydrographic staff, carried out in the laboratories of Queensland Health Scientific Services.
- The closest DERM monitoring site to the Project area is:
  - 120305A Native Companion Creek at Violet Grove.
- The station description includes:
  - latitude 23:34 South
  - longitude 146:40 East
  - stream length:109.4 kilometres
  - catchment area: 4065.0 square kilometres
  - monitoring commenced on 15/12/1967.

Native Companion Creek is a watercourse parallel to Lagoon Creek (see Figure 7.1). It flows into the Belyando River where it meets with Lagoon Creek's waters. The water quality of Native Companion Creek is considered comparable to the water quality of the creeks within the Project area, as they share similar characteristics, being upland freshwater streams above 150 m in elevation, ephemeral, and are in relatively close proximity to each other. The land surrounding Native Companion Creek is classified 2.1.0 – Grazing natural vegetation under the Australian Land Use Management (ALUM) system. It was assessed that the land has been disturbed by low intensity cattle grazing on native vegetation and coal exploration drilling, which is similar to the Lagoon Creek catchment.

Field measurements of various water quality parameters were measured at this station from 1968 to 2010. Tables 7.1 and 7.2 compare results against the ANZECC (2000) and Queensland Water Quality Guidelines (QWQG, 2006) guidelines. As not all the parameters were consistently analysed from 1968 to 2010, the number of readings for each parameter are indicated as 'n'. Parameter values in red text indicate exceedances compared to guideline values.



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Native Companion Creek Location

Table 7.1 Native Companion Creek – percentile calculations

Parameters	Date	n	Average	Mean	20th Percentile	80th Percentile	ANZECC SMD freshwater trigger values	
							Lower value	Higher value
Conductivity (uS/cm)	1978–2010	65	161.34	135.00	104.80	213.00	**30**	**250**
Turbidity (NTU)	1987–2010	39	307.71	200.00	56.68	452.00	**2**	**90**
Colour True (Hazen units)	1991–2010	33	44.76	21.00	11.00	63.60	**NE**	**NE**
Water Temperature (°C)	1973–2010	52	24.64	25.60	20.68	27.92	**NE**	**NE**
pH	1970–2010	60	7.32	7.34	7.00	7.60	**6**	**7.5**
Total Alkalinity (mg/L)	1970–2010	60	67.84	57.25	39.80	96.06	**60****	**NE**
Hardness (mg/L)	1970–2010	60	56.49	48.50	34.00	74.00	**NE**	**NE**
Total Dissolved Solids (mg/L)	1970–2010	60	104.83	89.92	76.00	140.00	**0***	**5,000 ***
Total Dissolved Ions (mg/L)	1970–2010	60	136.53	112.30	89.03	191.06	**NE**	**NE**
Total Suspended Solids (mg/L)	1973–2010	54	244.72	110.00	33.60	387.00	**NE**	**NE**
Calcium (mg/L)	1970–2010	60	13.25	11.15	7.76	18.92	**NE**	**1000 ***
Chloride (mg/L)	1970–2010	60	11.58	9.68	6.00	19.82	**NE**	**NE**
Magnesium (mg/L)	1970–2010	60	5.69	4.75	3.48	7.64	**NE**	**2,000***
Nitrate (mg/L)	1976–2010	47	1.79	1.20	0.67	2.39	**NE**	**0.7**
Total Nitrogen (mg/L)	1998–2010	12	1.01	0.95	0.86	1.34	**0.15**	**NE**
Organic Nitrogen (mg/L)	1995–2010	15	1.13	1.14	0.57	1.41	**NE**	**NE**
Nitrate + nitrite (mg/L)	1995–2010	28	0.08	0.04	0.01	0.11	**NE**	**NE**
Ammonia as N (mg/L)	1995–2010	28	0.05	0.04	0.02	0.06	**0.006**	
Dissolved Oxygen saturation (%)	1995–2010	30	73.90	72.13	59.65	91.65	**90**	**120**
Total Phosphorus (mg/L)	1994–2010	30	0.20	0.20	0.06	0.30	**0.01**	**NE**
Total Reacted Phosphorus (mg/L)	1995–2010	28	0.02	0.01	0.00	0.02	**NE**	**NE**
Sulphate (mg/L)	1974–2010	43	2.77	1.82	1.18	2.46	**NE**	**1,000***

Parameters	Date	n	Average	Mean	20th Percentile	80th Percentile	ANZECC SMD freshwater trigger values	
							Lower value	Higher value
Aluminium (mg/L)	1991–2010	32	0.25	0.05	0.00	0.22	0.055 (pH>6.5), NE (pH<6.5)	
Boron (mg/L)	1973–2010	38	0.05	0.05	0.00	0.10	0.37	NE
Copper (mg/L	1991–2010	32	0.04	0.03	0.00	0.05	0.0014	
Fluoride (mg/L)	1970–2010	59	0.19	0.18	0.11	0.26	2000*	NE
Iron (mg/L)	1973–2010	42	0.53	0.08	0.00	0.96	NE	NE
Manganese (mg/L)	1983–2010	34	0.01	0.01	0.00	0.02	1.9	
Zinc (mg/L)	1991–2010	32	0.02	0.01	0.00	0.05	0.008	

NE: Not Establish

*: Livestock drinking water quality guidelines

**: Irrigation water quality guidelines

Table 7.2 Native Companion Creek – Average monthly results

Month	Date	Jan	Feb	Mar	Apr	May	Jul	Aug	Sep	Oct	Nov	Dec
Number of samples taken/month during the indicated date range		8	8	8	4	5	1	6	3	2	10	8
Flow (ML)	1970–2010	10,663.12	10,549.41	2,277.14	11,854.45	4,346.77	499.44	115.51	176.45	783.70	841.67	2853.35
Conductivity (uS/cm)	1978–2010	105.50	95.84	171.64	170.48	191.50	290.00	178.33	213.80	119.00	134.23	208.15
Turbidity (NTU)	1987–2010	282.00	762.50	250.40	131.45	89.93	179.00	50.60	170.50	590.00	229.75	302.35
Colour True (Hazen units)	1991–2010	24.75	56.25	80.60	49.50	31.67	9.00	11.00	88.50	36.00	15.67	42.17
Water Temperature (°C)	1973–2010	26.49	25.77	27.91	24.40	20.02	10.80	19.37	21.33	24.60	26.64	30.88
pH	1970–2010	7.14	7.05	7.41	7.31	7.19	7.41	7.41	7.58	7.73	7.28	7.28
Total Alkalinity (mg/L)	1970–2010	39.13	40.92	72.51	70.20	76.88	114.40	72.30	56.03	111.09	58.12	82.88
Hardness (mg/L)	1970–2010	31.13	32.43	59.72	57.84	61.15	98.25	58.25	67.88	82.20	48.33	69.25
Total Dissolved Solids (mg/L)	1970–2010	69.25	67.26	109.95	99.95	121.03	157.94	108.59	124.85	156.92	86.96	120.97

Month	Date	Jan	Feb	Mar	Apr	May	Jul	Aug	Sep	Oct	Nov	Dec
Total Dissolved Ions (mg/L)	1970–2010	80.76	79.91	139.67	134.81	152.26	226.08	142.70	171.03	213.73	114.36	165.30
Total Suspended Solids (mg/L)	1973–2010	404.88	595.50	207.50	211.00	55.25	56.00	219.80	35.00	92.00	246.33	237.00
Calcium (mg/L)	1970–2010	7.35	7.48	14.56	12.78	14.64	22.90	13.57	15.50	19.80	11.98	15.35
Chloride (mg/L)	1970–2010	5.74	5.52	9.94	12.43	12.93	22.20	13.21	13.32	19.24	9.08	16.54
Magnesium (mg/L)	1970–2010	3.09	3.33	5.69	6.30	6.02	10.00	5.95	7.03	8.00	4.50	7.53
Nitrate (mg/L)	1976–2010	1.16	0.87	1.66	2.10	2.28	0.00	3.84	0.68	1.96	2.12	2.52
Total Nitrogen (mg/L)	1998–2010	0.89	1.24	1.16	NE	0.31	NE	NE	NE	NE	0.85	1.40
Organic Nitrogen (mg/L)	1995–2010	NE	1.11	0.92	1.08	1.29	1.24	0.66	1.24	1.05	1.41	1.47
Nitrate + nitrite as N (mg/L)	1995–2010	0.05	0.11	0.08	0.01	0.00	0.19	0.06	0.01	0.67	0.04	0.06
Ammonia as N (mg/L)	1995–2010	0.05	0.05	0.06	0.02	0.02	0.10	0.06	0.03	0.24	0.04	0.03
% DO saturation	1995–2010	59.08	86.44	70.95	52.18	80.29	59.56	94.45	101.59	68.48	65.48	78.88
Total Phosphorus (mg/L)	1994–2010	0.20	0.33	0.21	0.20	0.13	0.10	0.03	0.17	0.29	0.23	0.22
Total Reacted Phosphorus (mg/L)	1995–2010	0.02	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.02
Sulphate (mg/L)	1974–2010	3.47	1.53	2.30	1.22	3.11	1.30	3.97	6.94	3.42	2.85	1.36
Aluminium (mg/L)	1991–2010	0.56	1.05	0.11	0.05	0.06	0.00	0.01	0.15	0.03	0.02	0.04
Boron (mg/L)	1973–2010	0.06	0.05	0.06	0.05	0.06	0.10	0.06	0.10	0.00	0.04	0.05
Copper (mg/L	1991–2010	0.04	0.04	0.02	0.02	0.02	0.04	0.01	0.07	0.01	0.02	0.01
Fluoride (mg/L)	1970–2010	0.15	0.10	0.16	0.18	0.26	0.22	0.21	0.18	0.17	0.25	0.24
Iron (mg/L)	1973–2010	1.00	0.59	0.55	0.44	0.11	0.00	0.71	0.26	0.05	0.31	0.14
Manganese (mg/L)	1983–2010	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Zinc (mg/L)	1991–2010	0.07	0.02	0.01	0.03	0.00	0.00	0.01	0.02	0.01	0.02	0.01

NE: Not Establish

7.1.2 Project specific data

Two surface water and sediment sampling surveys were performed from the 16 March to 21 March 2009 and 15 March to 22 March 2010 for the Proponent, which provided a snapshot of indicative water and sediment quality at the time of sampling. A large number of locations were surveyed, however only some are relevant to the watercourses within or immediately surrounding the Project area.

Parsons Brinckerhoff has had limited visibility regarding the sampling and analysis methodology used during the surveys and subsequent sample analysis.

In summary, the data quantity and sampling rationale does not allow for conclusive assessment of the condition of the watercourses in comparison to recognised standard assessment methodologies, included in the ANZECC (2000), and Queensland Water Quality Guidelines. Therefore, the Project specific data has not been presented in this technical report for assessment.

7.1.3 Water quality findings

Generally, ephemeral creeks are subject to change in water quality due to flow changes. Indeed, as flow decreases, water quality at a location becomes progressively less dependent on upstream inflows and more dependent on local effects. During low flow periods, waterholes can be formed and the water quality will be affected by the size of the waterhole and the length of the non–flow period. The smaller the waterhole and the longer the non–flow period, the more significant these changes are likely to become.

Thus, the approach for applying guideline values to non–flowing streams will depend on indicators.

The findings are based on the historical data available for Native Companion Creek, and include:

- pH was consistently within the range at Native Companion Creek, with exceedances recorded for the 80th percentile
- the percentage of dissolved oxygen saturation was somewhat low for Native Companion Creek throughout the year
- physical indicators like dissolved oxygen and pH become much more variable during stagnant conditions as a result of photosynthesis and it was observed that all points with pH exceedance occurred during period of no flow. It is likely that the formation of a small waterhole would allow for water sampling to be performed at Companion Creek and would explain the pH variation. Application of the ANZECC (2000) guidelines for pH to small waterholes in non–flow conditions is inappropriate. However, in larger waterholes it would be expected that values would remain closer to guidelines, although this will vary depending on a range of factors such as the size, depth and vegetation cover of the waterhole. Further information regarding the geomorphology of Native Companion Creek monitoring station is required to enable further assessment. In contrast with the pH measurements, no clear relationship between flow and low dissolved oxygen concentrations was found. The low percentage of dissolved oxygen appears to be a consistent feature of the waterbodies in the Project regions and therefore the application of the ANZECC (2000) guidelines is inappropriate

- the available turbidity data was found to be very high in particular at Native Companion Creek

- the high turbidity is typical of temporary or ephemeral streams which are characterised by temporary water flow from short–lived rain events of various intensities and distributions (Smith *et al.* 2004). This suggests that the catchment condition is somewhat degraded, and is likely to be impacted during heavy rainfall events. The low density vegetation cover of the Burdekin region promotes sediment–laden runoff associated with soil erosion from hillslopes, gullies and banks, and associated distribution via runoff which leads to high turbidity (Faithful and Griffiths 2000). This also consolidates the assumption that the watercourses are likely to be characterised as ‘moderately to slightly disturbed’ aquatic systems, particularly due to agricultural/grazing practices

- the historical water quality values from Native Companion Creek for ammonium, TP nitrate and TN consistently exceeded ANZECC (2000) guideline values, as shown in the tables above

- this identifies historical nutrient pollution in areas adjacent to the Project areas, which is assumed to be representative of the Project area. These nutrient concentrations are typically generated from the diffuse runoff from areas under agricultural land use such as cattle grazing, and other nutrient concentrating activities

- measures for toxicants in Native Companion Creek significantly exceed the ANZECC (2000) guidelines, including copper and zinc.

For toxicants for both water and sediment, it is appropriate to apply ANZECC (2000) guidelines, as the effects on the biota under stagnant conditions will be similar to those during flowing conditions however, the ANZECC (2000, p. 8.3–44) guideline also states the following in relation to stated guideline trigger values for metals:

> ‘*Natural background concentrations of some chemicals, particularly metals, may exceed the stated guideline trigger values due to mineralisation from the catchment substrate, as distinct from anthropogenic sources. In such cases, it would be unreasonable to insist on a guideline value below the background concentration. High levels of naturally–occurring metals in highly mineralised areas are not necessarily indicative of adverse environmental effects due to possible adaptation of the local fauna*’.

8. Potential impact and mitigation measures

The potential impacts of the proposed mine on water quality and proposed mitigation measures are presented in detail in Table 8.1 for the construction phase and Table 8.2 for the operational phase and described briefly below.

The mine operation has the potential to impact on downstream water quality as well as the groundwater resource. Indeed, where rock and soil is exposed to rainfall as part of any mining activities, it carries sediments and salts, metals, trace elements, and/or organic compounds that may impact surface water quality.

The potential impacts associated with construction and operational activities in the Project area, including vegetation clearing, creek diversions, and drainage of structures may result in:

- increased and/or exacerbation of erosion and sedimentation and poor drainage
- pollutants contaminating waterbodies
- increased runoff from water received as rainfall and/or water from underground seepage. A water management system comprising a network of water management infrastructure will allow for flexibility in transport and storage of water around the site. The key water management goal for the Project will be to minimise downstream impacts from the proposed mining operation
- increased weed infestation
- leaching of salts, acid forming material, metals and trace elements into groundwater causing potential surface water and groundwater quality impacts
- environmental incidents resulting from unregulated discharges of pollutants or polluted waters that do not meet water quality discharge criteria into waterbodies.

Water quality mitigation measures and water management practices that will help prevent surface water pollution at and downstream of the Project area, including:

- ensuring that erosion and sediment control measures are in place prior to any ground disturbance
- ensuring that appropriate water quality criteria are established for all discharges into surface waters through suitable licensing and permitting
- ensuring that water treatment and water management methods, are designed to ensure that discharges meet the defined discharge criteria
- ensuring that surface water releases are regulated in accordance with water quality criteria through appropriate water and site management practices.

Overall, the management of mining operations in accordance with the Environmental Management Plan (EM Plan), Plan of Operations and accompanying Water Management Plan and Erosion and Sediment Control Plan (ESCP), and Environmental Management System will reduce the likelihood of the potential impacts associated with mining operations, soil erosion, and environmental incidents, through implementation, monitoring and auditing of the relevant plans and systems.

Table 8.1 Potential impacts and mitigation measures during the construction phase

Issue	Potential impacts	Mitigation measures
Construction phase		
Impacts of construction in the Project area resulting in increased erosion and sedimentation.	Soil erosion and sediment transportation and deposition that may have the following effect on the environment: ▪ on–site effects: loss of topsoil, buried vegetation and buffer zones, clogged drainage infrastructure and increased flooding, silting and bank damage to trench works and drainage structures (on construction sites), localised flooding, increased downtime on construction sites after storm events, visual impact, siltation and loss ▪ off–site effects: siltation of watercourses and aquatic habitats, introduction of exotic weed species, increased pollution of streams, adverse ecological effects of de–silting of waterways.	Design erosion and sediment control measures as part of the temporary and permanent drainage systems. Where possible, avoid disturbance to natural watercourses and riparian areas, and reinstate any disturbed areas. Reduce or limit overland flow runoff volume and velocity by minimising catchment size, increasing flowpath length, and providing for water infiltration into soils. During the construction phase, early planning and construction of temporary drainage systems will minimise erosion and avoid delays in initial earthworks. Drawings detailing existing flowpaths, both temporary and permanent drainage, including design capacities, identification of all proposed temporary and final overland flow paths, and any proposed diversions of overland flowpaths. Diversion of upslope water to reduce on–site erosion by limiting catchment size, thereby reducing total volume of contaminated runoff requiring treatment and reduced downtime following prolonged rain events. Install permanent drainage structures as early as possible, including stabilised drainage outlets. Development and application of an approved Erosion and Sediment Control Plan (ESCP) including the following: ▪ identification of soil and water management issues, including existing site conditions, soil and climatic data, erosion prone areas, location of the nearest and other relevant environmentally sensitive areas. Please refer to the Geomorphology stream technical report for additional details ▪ clear understanding and application of proposed control measures including the following actions — minimise disturbance, provide temporary and permanent drainage measures as early possible, identification of suitable erosion and sediment controls for the site, implement effective revegetation ▪ drawings to accompany the ESCP identifying the development and staging of works of temporary erosion and sediment control measures, including measures to cope with heavy rainfall events to aid in limiting unforseen construction delays due to wet weather ▪ compliance with the recognised approval processes ▪ maintain and supervise implementation of the ESCP, and undertake scheduled inspections of the implementation of the ESCP ▪ undertake monitoring of the effectiveness of the ESCP including diary

Issue	Potential impacts	Mitigation measures
		notes/logbook entries of control techniques used on–site, and water quality sampling both upstream and downstream of disturbed areas.
Impacts of construction in the Project area resulting in pollutants contaminating waterbodies	Soil and water contamination due to inappropriately stored and handled materials, hydrocarbons and other potentially hazardous substances	Suitable containment and bunding in accordance with Australian Standards of potential surface water pollutants such as hydrocarbon based products, including fuels, oils, greases, and lubricants; solvents such as paints, and thinners; and powders/dusts/granular materials including powder coating materials, cement, and ammonium nitrate. Containment, storage and handling of potentially contaminating substances and materials depends on the type and quantity of each. Generally, stormwater from the MIA, and ammonium nitrate fuel oil (ANFO) facility will be captured and treated through oil/water separators. Effluent from the separators will be discharged to environmental dams, sediments to the tailings dam, and oils removed from site to a licensed waste facility. Surface water from within mine pits, the ROM pads, remote fuelling facilities, CHPP, and product coal stockpile discharge to environmental dams. Further information on dam location and sizing is provided in the Water Management System and Water Balance technical report.
Impacts due to creek diversions. Spring Creek and Sandy Creek will be diverted to respectively southern and northern watercourse diversions.	For major creek diversions during operation of the mine pits, potential impacts on water quality include decreases in quality due to significant erosion and sedimentation from unstable diverted channels, downstream sedimentation of existing waterways, and increased EC and turbidity due to erosion of dispersive soils.	Develop a detailed creek diversion strategy for all creek diversions, with timeframes allowing establishment of stable, vegetated creek channels prior to carrying entire flows of diverted creeks. The strategy is to be included in the water license application to divert declared watercourses, and will form part of the Plan of Operations, including consultation with and associated water licensing from the Department of Environment and Resource Management. Development of the detailed creek diversion strategy to include: ▪ geomorphology assessment of affected creeks ▪ topographical survey of affected creeks and areas to be diverted into ▪ terrestrial and aquatic ecology assessments of the existing creeks ▪ water quality assessments of the existing creeks ▪ hydrological studies ▪ design of creek diversions which meet guidelines of NRW Watercourse Diversions – Central Queensland Mining Industry ▪ rehabilitation and revegetation plans of each creek diversion to define and establish requirements, based on assessments as given above and detailed design. ▪ implementation of a specific and targeted water quality monitoring program, with further details provided in section 9 of this report.
Drainage structures and	Failure to provide adequate drainage may lead to increased	Undertake early planning, design and construction of drainage systems, when

Issue	Potential impacts	Mitigation measures
supporting facilities.	surface runoff, soil erosion, slope instability, differential settlement of foundations, flooding, periodic water–logging of low–lying areas, and revegetation difficulties.	required, to minimise erosion. Develop and implement the ESCP for each phase of construction task.
Measures to reduce weed infestation.	Weed infestation of construction areas and weed distribution downstream.	Implement on–site measures to minimise weed infestation including washdown of off–site equipment prior to use on site, ensuring only clean imported fills and soils are brought onto site, and appropriate application of herbicides. Ensure development and application of a Weed Management Plan to be applied during the construction phase.

Table 8.2 Potential impacts and mitigation measures during the operational phase

Issue	Potential impacts	Mitigation measures
Operation phase		
Impacts of operation in the Project area resulting in pollutants contaminating waterbodies	Soil and water contamination due to inappropriately stored and handled materials, hydrocarbons and other potentially hazardous substances.	Suitable containment and bunding in accordance with Australian Standards of potential surface water pollutants such as hydrocarbon based products, including fuels, oils, greases, and lubricants; solvents such as paints, and thinners; and powders/dusts/granular materials including powder coating materials, cement, and ammonium nitrate. Containment, storage and handling of potentially contaminating substances and materials depends on the type and quantity of each. Generally, stormwater from the MIA, and ammonium nitrate fuel oil (ANFO) facility will be captured and treated through oil/water separators. Effluent from the separators will be discharged to environmental dams, sediments to the tailings dam, and oils removed from site to a licensed waste facility.
Impacts of additional surface water.	Infiltration of additional surface water to groundwater.	Saline groundwater seepage into pits and surface waters will be controlled by environmental dams. Water in the environmental dams will be subject to no planned discharges, with reuse of water across the mine proposed when water is of a suitable quality.
Drainage structures and supporting facilities.	Failure to provide adequate drainage may lead to increased surface runoff, soil erosion, slope instability, differential settlement of foundations, flooding, periodic water–logging of low–lying areas, and revegetation difficulties.	Recognise drainage requirements early in the design phase. Develop understanding of physical limitations that may affect drainage structures and supporting facilities, including soil type, topography, water supply and vegetation. Undertake early planning, design and construction of drainage systems to minimise erosion and avoid delays in initial earthworks. Install permanent drainage systems as soon as practicably possible. Develop and implement the ESCP for each phase of operations, being included in the Plan of Operations for the operational phase of the mine.
Measures to reduce	Weed infestation of operational areas and weed	Implement on–site measures to minimise weed infestation including washdown of off–site

Issue	Potential impacts	Mitigation measures
weed infestation.	distribution downstream.	equipment prior to use on site, ensuring only clean imported fills and soils are brought onto site, and appropriate application of herbicides. Ensure development and application of a Weed Management Plan as part of the Plan of Operations. Implement a rehabilitation and revegetation plan to establish a groundcover that will be self regenerating and provide sustainable erosion control as part of the Plan of Operations.
Surface water runoff and leaching of salts, metals, and trace elements into deeper levels causing potential surface water quality and groundwater quality impacts.	Pollution of surface water and groundwater due to mine operations. The geochemical characteristics suggest that the mine products and by–products could potentially impact on the surface water of the watercourses within and downstream of the Project, if not appropriately managed.	Implement a site based Water Management Plan, with further information provided in the Water Management System and Water Balance technical report. Implement a water quality monitoring program associated with the Project area. The selection of the water quality indicators therefore will take into account all possible contaminants arising from the mine overburden, coal and coal waste. This includes among others, the measurements of heavy metal concentrations, pH, hardness and OP to be included. A final list of parameters and monitoring criteria will be developed based on the findings of the proposed water quality monitoring, as discussed further in section 9 of this report. Each of the dams on site will be monitored as required for applicable water quality parameters, depending on the dam type and fate of water. Discharges to the environment would be controlled via the final SRD. All SRDs will be monitoring for water quality parameters and flow to establish individual contributions to the overall sediment runoff control system. Discharges from the final SRD will be required to meet release criteria for quality and flow. Further information is provided in the Water Management System and Water Balance technical report.

8.1 Interim water quality release limits

No site specific Environmental Values are available for the Project area, so ANZECC (2000) guidelines for ‘slightly to moderately disturbed system’, were used for comparison purposes with the historical data from Native Companion Creek. However because the watercourses are ephemeral and the water quality differs under this type of flow regimes, the Queensland Water Quality (QWQ) guidelines recommend the development of local guidelines rather than applying the default ANZECC values.

Trigger values can be derived from historical data, however too few historical data records on surface water quality were available for this assessment. In addition, the available site specific data quantity and sampling rational did not allow for conclusions to be reached on the condition of the watercourses in the Project area. Nevertheless, Section 7.1.3 of this report further promotes the development of local guidelines as it was observed that multiple parameters measured in Native companion Creek showed regular exceedances of the ANZECC (2000) trigger values.

Consequently, the development of a baseline monitoring program is required and should be commenced as soon as possible. Further details of the monitoring program are provided in Section 9.

The main objectives of the monitoring program will be to collect:

- data from reference sites and derive local values for physio–chemical and biological parameters
- background data on all the watercourses within the Project area to assess the condition of the watercourses prior to the commencement of Project construction.

Following the completion of the baseline monitoring program, local values for the watercourses within the Project area should be established and contaminant release limits, and trigger investigation levels formalised. Interim release limits and trigger investigation levels are provided in the Tables 8.3 and 8.4 and should be applied to the final SRD release point. Interim release limits and trigger investigation levels should also be applied to other potential release points located on overtop spillways on environmental dams. The release limits and trigger investigation levels are set according to the trigger values provided by ANZECC (2000) guidelines.

It is worth noting that different trigger values are provided by the ANZECC (2000) guidelines depending on the potential EV attributed to the site – protection of aquatic ecosystem of slightly to moderately disturbed ecosystem, primary industrial use and recreational and aesthetic use as defined in Section 5.1 of this report (no trigger value is provided for cultural and spiritual use). For each of the parameters listed below the trigger values for the different EV were compared where available, and the most stringent trigger values adopted, except for parameters showing constant exceedance to the guidelines. For these parameters the 80^{th} percentile of the Native Companion Creek is adopted.

Following baseline monitoring, it is recommended that site specific release limits and trigger investigation levels based on the available data be applied in the Environmental Authority. The release to Lagoon Creek from the final SRD must only take place during periods of natural flow events specified with a minimum flow. For more details on recommended release flow rates, refer to the Water Management System and Water Balance technical report.

Table 8.3 Contaminant release limits

Parameters	Release limits	Monitoring frequency
pH	6.0 (minimum)* 9 (maximum)	Daily during release with the first sample taken within two hours of the commencement of release
Turbidity (NTU)	452 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release
Electrical conductivity (µS.cm^{-1})	2,000 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release
Total Suspended solids (mg/L)	5,000 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release
Dissolved Oxygen (%)	59.65 (minimum)* 120 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release
Sulphate (mg/L)	1,000 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release
Ammonia (mg/L)	0.9 (maximum)*	Daily during release with the first sample taken within two hours of the commencement of release

*: local trigger values to be developed prior to notification of the draft EA

Table 8.4 Release contaminant trigger investigation levels

Parameters	Release limits	Monitoring frequency
Total Phosphorus (mg P/L)	0.3 (maximum)*	80th percentile of Native Companion Creek data
Total Nitrogen (mg N/L)	1.34 (maximum)*	80th percentile of Native Companion Creek data
Calcium (mg/L)	1,000 (maximum)*	ANZECC value for livestock drinking water protection
Nitrate (mg N /L)	1.34 (maximum)*	80th percentile of Native Companion Creek data
Fluoride (mg/L)	2,000 (maximum)*	ANZECC value for livestock drinking water protection
Aluminium (mg/L)	0.2 (maximum)*	80th percentile of Native Companion Creek data
Arsenic (mg/L)	0.013 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection
Boron (mg/L)	0.37 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection
Cadmium (µg/L)	0.2 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection
Chromium (mg/L)	0.001 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection
Copper (mg/L)	0.05 (maximum)*	80th percentile of Native Companion Creek data
Cobalt (mg/L)	0.09 (maximum)*	Fitzroy Basin trigger limits
Iron (mg/L)	0.3 (maximum)*	Fitzroy Basin trigger limits
Lead (µg/L)	10 (maximum)*	Fitzroy Basin trigger limits
Manganese (mg/L)	1.9 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection
Mercury (µg/L)	0.06 (maximum)*	ANZECC 99% SMD value for aquatic ecosystem protection
Molybdenum (mg/L)	0.034 (maximum)*	Fitzroy Basin trigger limits
Nickel (mg/L)	0.011 (maximum)*	ANZECC 95% SMD value for aquatic ecosystem protection

Parameters	Release limits	Monitoring frequency
Selenium (mg/L)	0.010 (maximum)*	Fitzroy Basin trigger limits
Silver (mg/L)	0.001 (maximum)*	Fitzroy Basin trigger limits
Zinc (mg/L)	0.05 (maximum)*	80th percentile of Native Companion Creek data
Vanadium (mg/L)	0.01 (maximum)*	Fitzroy Basin trigger limits
Uranium	0.001 (maximum)*	Fitzroy Basin trigger limits
TPH (C6-C9) (mg/L)	20 (maximum)*	Fitzroy Basin trigger limits
TPH (C6-C9) (mg/L)	100 (maximum)*	Fitzroy Basin trigger limits

*: local trigger values to be developed prior to notification of the draft EA

9. Monitoring program

Two monitoring programs are described below:

1. A baseline monitoring program designed to collect additional background data and derive site specific trigger values. This program is to be implemented as soon as practical and completed before mine operation commences.
2. An on–going monitoring program developed for the continuous monitoring of the watercourse water quality while the mine is operating. This includes the control of discharges from the proposed release point from the final SRD.

9.1 Baseline monitoring program

As limited relevant Project specific background data was available for assessment as part of the EIS, a monitoring program shall be implemented prior to the development of the mine to establish more background data and a baseline for development of site specific trigger parameters.

9.1.1 Program objectives

The main objective of the initial monitoring program is to derive regional and site specific guidelines that will then be used for comparison against the water quality monitoring program for the construction and operation of the mine.

9.1.2 Monitoring locations for Reference sites

Two reference sites will be monitored to collect data and establish derived values for physio–chemical and biological parameters. Reference sites refer to sites that are subject to minimal/limited disturbance. According to ANZECC (2000) guidelines, a reference site is a site whose condition is considered to be a suitable baseline or benchmark for assessment and management of sites in similar waterbodies. The condition of the site is a reference condition and values of individual indicators at that site are the reference values.

The criteria adopted by the Queensland Water Quality Guidelines for minimally disturbed reference sites are shown in Table 9.1.

Table 9.1 Reference sites selection criteria

No	Freshwaters
1	No intensive agriculture within 20 km upstream. Intensive agriculture is that which involves irrigation, widespread soil disturbance, use of agrochemicals and pine plantations. Dry–land grazing does not fall into this category.
2	No major extractive industry (current or historical) within 20 km upstream. This includes mines, quarries and sand/gravel extraction.
3	No major urban area (>5000 population) within 20 km upstream. If the urban area is small and the river large this criterion can be relaxed.
4	No significant point source wastewater discharge within 20 km upstream. Exceptions can again be made for small discharges into large rivers.
5	Seasonal flow regime not greatly altered. This may be by abstraction or regulation further upstream than 20 km. Includes either an increase or decrease in seasonal flow.

Two reference sites are identified in the Figure 9.1 and Table 9.2.

Table 9.2 Proposed reference sites

No	Reference site	Acronym	Coordinates		Comment
			Easting	Northing	
Well Creek –Cudmore National Park					
1	Well Creek	WC	466460	7392765	Within the Cudmore National Park – pending access approval
Native Companion Creek					
2	Native Companion Creek	NCC	466502	7392714	Existing Native Companion Creek gauging station - pending access approval by DERM

- Well Creek is a parallel stream to Sandy Creek and Spring Creek. The water quality of Well Creek is considered comparable to the water quality of the creeks within the Project area, as they share similar characteristics, being upland freshwater streams above 150 m in elevation and are ephemeral. The land surrounding the Well Creek is classified as National Park and low intensity grazing can be expected. No significant intensive activities were identified upstream of Well Creek at the time of this assessment (Liam Balderson, Land Use officer, Barcaldine Council – pers. comm.03.08.2010).

- Native Companion Creek is a parallel watercourse to Lagoon Creek. The water quality of Native Companion Creek is considered comparable to the water quality of the watercourses within the Project area, as they share similar characteristics, being upland freshwater streams above 150 m in elevation and are ephemeral. The land surrounding the Native Companion Creek is mainly used for low intensity cattle grazing. No significant intensive activities were identified at the time of this assessment (Liam Balderson, Land Use officer, Barcaldine Council – pers. comm.03.08.2010).

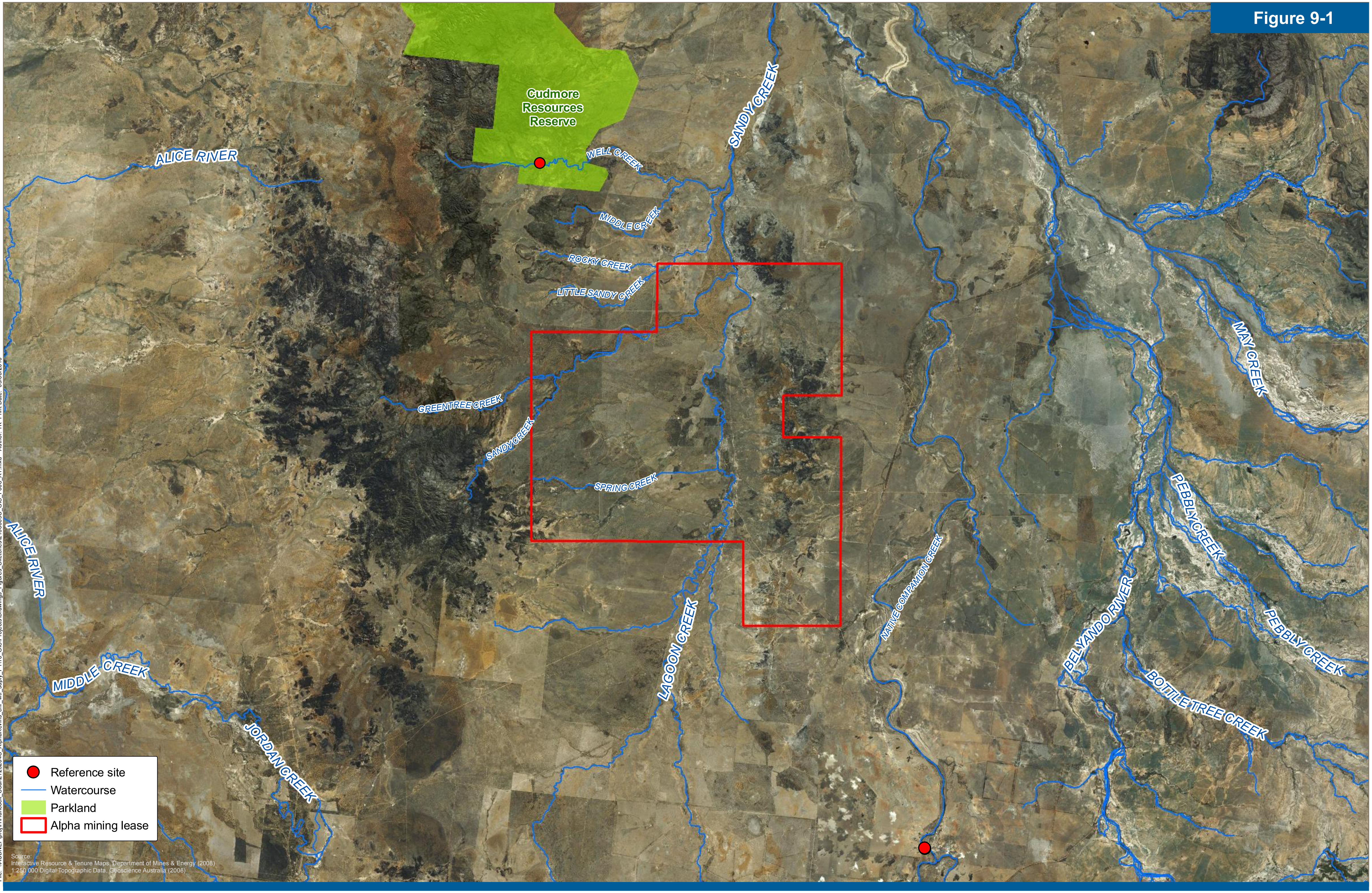
The two sites comply with the conditions one to four listed in the Table 9.2, but both creeks are ephemeral and hence have flow regimes that are greatly altered across seasons. Although the criteria in Table 9.2 are recommended, the ANZECC guidelines acknowledge that there are some water types where it may be difficult to find any sites that fully comply with these criterions. In this situation it may be necessary to use lesser quality or best available sites. The two references sites used for this baseline exhibit the least deviation from the criteria in Table 9.1.

While data from reference sites is critical to establish a baseline in accordance with the ANZECC (2000) guidelines criterion, it is recommended to perform the same monitoring program at the locations identified in the Table 9.6 in order to collect background data prior to the mine activities commencement.

9.1.3 Sampling frequency

Watercourses located within and surrounding the Project area are ephemeral, and only flow after heavy rainfall. Watercourses located within and surrounding the Project area are ephemeral, and only flow after heavy rainfall. The preferred method of water quality sampling for ephemeral streams are automated samplers and/or data logger– for monitoring highly variable parameters such as DO, pH or electrical conductivity – as they will continuously be available to take measurements.

Figure 9-1



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Reference site location

Also, automated samplers can be used to alert staff of flow events and indicate that grab sampling can be undertaken. Therefore, the use of automated samplers and grab sampling is recommended as part of this monitoring program. However the sample collection method adopted (for example rising/falling stage automated samplers, probe with data logger, grab samples) will be finalised following a thorough site assessment and will be designed in compliance with requirements of the DERM Monitoring and Sampling Manual 2009 and ANZECC (2000) guidelines.

Sampling events will correspond with rainfall events that generate enough runoff to trigger sampling. Please note that routine (i.e. weekly/monthly) sampling would be more appropriate for water quality ambient assessment, and it should be applied at sampling locations where regular stream flow exists.

For the baseline and background sampling, the ANZECC Monitoring Guidelines suggest frequent sampling. Like most statistical measures, errors in percentile estimates will reduce with increasing sample size. Therefore to ensure that the 20th and 80th percentile estimates (ANZECC guideline for moderately disturbed waters) reflect the true population values, it is recommended that, for one to two reference sites, estimates of 20th or 80th percentiles at a reference site should be based on a minimum of 18 samples collected at each site over at least 12 and preferably 24 months (in order to capture two complete annual cycles). Given that such large data sets are rarely available outside government agencies, percentile estimates based on eight or more samples could be used to derive interim guidelines on the understanding that further data would be collected and guideline values updated accordingly.

Typically, sampling should occur monthly or twice monthly from October through March (i.e. summer wet season months), consisting of biological, physical and chemical measurement parameters on water and sediment and for each rainfall event creating sufficient flow to perform analysis.

9.1.4 Measurement parameters

The ANZECC Monitoring Guidelines stipulate that the choice of measurement parameters depends of EVs assigned to the waterbody. No EVs have been assigned to the waterbodies in the Project area under the Environmental Protection (Water) Policy 2009.Therefore to ensure a comprehensive assessment of the water quality of the watercourses, a large number of parameters, as listed in Table 9.3, have been proposed for the baseline monitoring.

The selection of parameters was based on the report '*A study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin*' and '*The Final Model Water Conditions for Coal Mines in the Fitzroy Basin*' published by the Queensland Government in 2009. The study focuses on discharges from coal mining operations as the Fitzroy River Basin's large–scale mining activities are dominated by coal mining and planned coal mine expansions. Consequently, parameters selected by DERM in this study are particularly relevant to this report.

Table 9.3 Recommended water quality parameters

Group	Parameters	Parameter rational
Physio–Chemical	Ammonium (NH^{4+})	Indicator of nutrient enrichment and algae growth which might be due to water pollution from existing land use activities.
	Dissolved Oxygen (DO)	Major generic parameters for data analysis
	Electrical conductivity	Provides an indication of the presence of metals, sulphate and other compounds possibly related to the release of contaminated water
	Turbidity	Major generic parameter for data analysis
	Total Suspended Solids	Major generic parameter for data analysis
	Temperature	Major generic parameter for data analysis
	pH	Major generic parameter for data analysis
	Alkalinity	Major generic parameter for data analysis
	Hardness	Metal toxicity values increase with increasing water hardness. The ANZECC 2000 guidelines provide multiplication factors to account for the effect of varying water hardness on toxicity for cadmium, chromium, copper, lead, nickel and zinc
	Moisture	Major generic parameter for sediment data analysis
	Particles sizing	Major generic parameter for sediment data analysis
	Acidity	Major generic parameter for data analysis
	Major cations and anions	Major generic parameter for data analysis
Inorganics	Sulphate	Indicator of natural sulphate contents occurring in the region. During mine activities, variation in the sulphate content could indicate uncontrolled mine drainage
	Nitrate	Indicators of agricultural water quality pollutants and mine activities.
	Calcium	Major generic parameter for data analysis
	Fluoride	Major generic parameter for data analysis
Generic	Oil and petroleum hydrocarbons	Oil/diesel and grease pollution from potential spill
Metals and Metalloids (dissolved and total)	Aluminium Arsenic Boron Cadmium Chromium Cobalt Copper Iron Lead Manganese Mercury Molybdenum Nickel Selenium Silver Uranium Vanadium Zinc	Indicators of natural metal contents occurring in the region. During mine activities, variation in the metal content could indicate uncontrolled mine drainage

9.1.5 Water quality monitoring schedule for reference sites

The recommended water quality monitoring schedule is provided in Table 9.4. The water quality monitoring schedule provides a sampling program consisting of location, monitoring parameter, and sampling frequency. This schedule only applies to background water quality monitoring, and does not apply to water quality monitoring during operation of the proposed mine. Due to the ephemeral character of the watercourses in the Project area and surrounds, sampling will not be routine and will occur during stream flow events only.

Details of sample collection (for example rising/falling stage automated samplers, probe with data logger, grab samples) to be used for each of the parameters will ultimately be at the discretion of the competent person undertaking the sampling, as long as sampling and monitoring is in compliance with requirements of the DERM Monitoring and Sampling Manual 2009 and ANZECC (2000) guidelines.

Table 9.4 provides a recommended template for recording sampling events.

Table 9.4 Water quality monitoring schedule

Monitoring sample type	Water quality parameter		Sample frequency
Fully automated sampling stations	pH Temperature EC Turbidity DO TSS Sulphate		At least daily when flow is detected.
Event Sampling	Matrix: Water	Matrix: Sediment	Weekly during and after major rainfalls and flow events.
	Electrical conductivity pH Turbidity TN TP Chlorophyll a Acidity Alkalinity as $CaCO_3$ Major cation and anions TPH ***Metals (total and dissolved):*** Aluminium (Al) Arsenic (As) Boron (B) Cadmium (Cd) Copper (Cu) Cobalt (Co) Chromium (Cr) Iron (Fe) Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Uranium Vanadium (Va) Manganese (Mn)	Electrical conductivity Acidity Alkalinity as $CaCO_3$ Moisture Particles sizing ***Metals (total for particles <63µm and >63 µm and dissolved):*** Aluminium Arsenic (As) Boron Cadmium (Cd) Copper (Cu) Cobalt Chromium (Cr) Iron Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Uranium Vanadium Manganese (Mn)	

Table 9.5 Water quality monitoring template

Monitoring sites		Event				Monitoring parameters
Stream	Code	No. Event	Start date and commencement time	Duration	No Sample	For all Locations
Example: Well Creek	WC	1	03/11/2010, 9:06 am	15 h	11	Electrical conductivity pH TSS Turbidity TN TP Chlorophyll a Acidity Alkalinity as $CaCO_3$ Major cation and anions ***Metals (total and dissolved):*** Aluminium (Al) Arsenic (As) Boron (B) Cadmium (Cd) Copper (Cu) Cobalt (Co) Chromium (Cr) Iron (Fe) Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Uranium Vanadium (Va) Manganese (Mn) Sulphate

9.2 On–going monitoring program

9.2.1 Program objectives

A routine on–going monitoring program will be implemented to allow effective water quality monitoring of the watercourses upstream and downstream of the mine site as well as the water quality at the final SRD discharge point. It will also allow for performance review of the various mitigation measures and plans implemented to protect the integrity of the waterbodies within the Project area.

The program is designed to demonstrate that the mine's operations are not creating unacceptable environmental effects on surrounding watercourses and receiving waters, including stream ecological and physical process. Site selection for this program was based on the basic premise that the quality of the water inflowing the mine area should be the same as the quality of the water leaving the mine site.

9.2.2 Monitoring locations

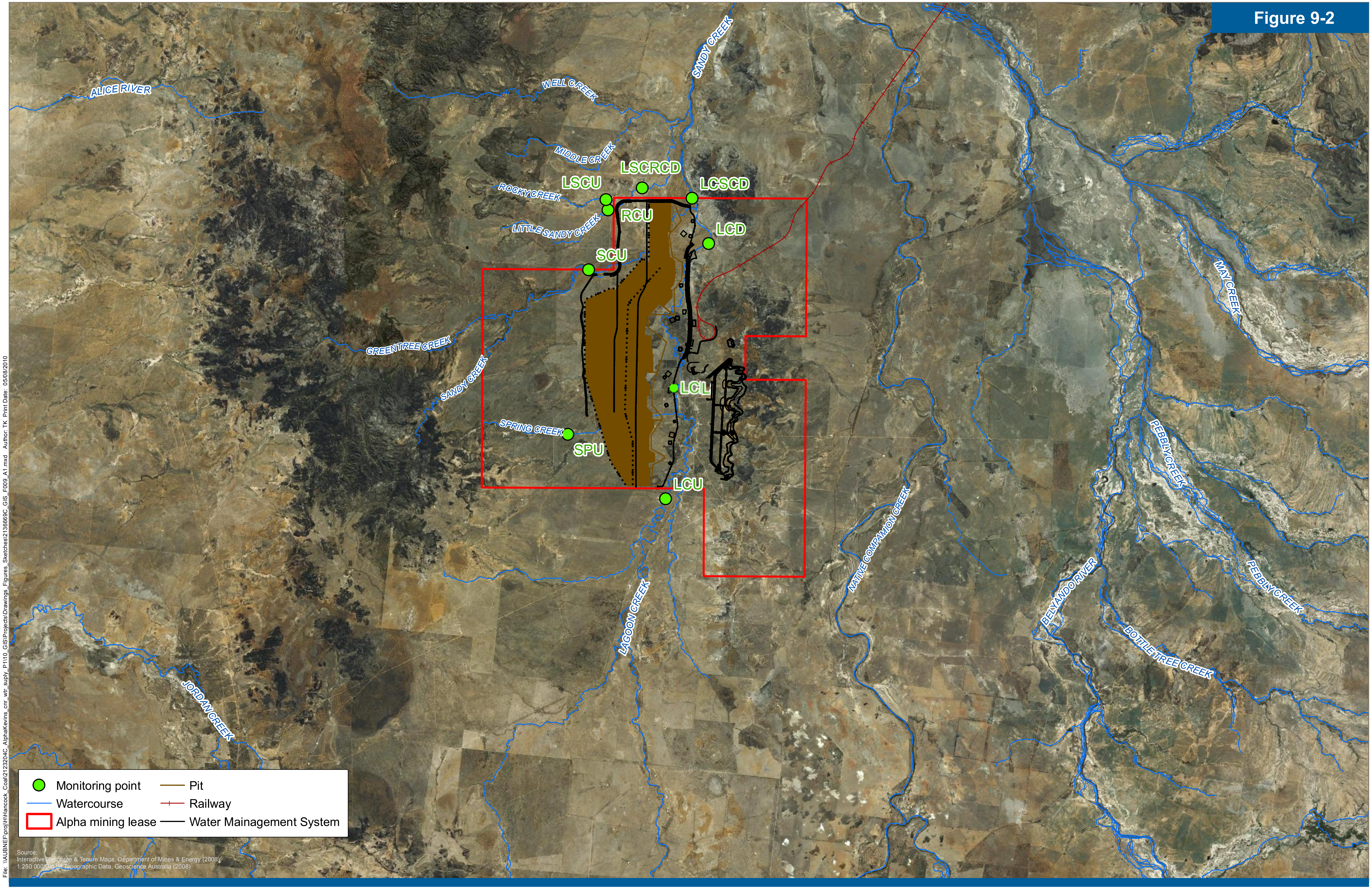
The monitoring locations outlined in this section, aim to spatially detect generation of pollutants that affect the receiving environment from the Project area. This report does not identify any particular features that may cause excessive pollutant generation/delivery to watercourses within the study area. Consequently, the spatial setup of ambient monitoring locations has been based on the current condition of key watercourses and the following:

- representative of either high or low impact from the mine activities
- 'low flow' areas (i.e. dams or pools) where it is anticipated that contaminants and sediments may accumulate
- accessibility during flow events
- representative/indicative of the majority of the watercourse system.

The nominated water quality monitoring sites correspond to the five key streams identified within or immediately adjacent to the Project area to ensure that water quality data presents a complete picture of the water quality condition of all watercourses located within the Project area. The proposed water quality monitoring sites (refer Figure 9.2) have been located upstream and downstream of the mine tenure boundary. These locations are suitable for background monitoring (i.e. pre–mine) and during the mining operation.

Table 9.6 provides the locations of recommended water quality monitoring sites for the long term operation of the mine.

While not specifically required by the legislation, it is highly recommended to carry out sampling as per the baseline monitoring program during the two–year prior to the mine activities commencement to collect on–site background data.



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Monitoring site location

Table 9.6 Coordinates of water quality and sediment monitoring sites

Number	Monitoring site	Code	Coordinates		Comment
			Easting	Northing	
Lagoon Creek					
1	Lagoon Creek upstream	LCU	447249.7	7418923	For conditions prior to entering the mine site
2	Lagoon Creek	LCL	448159	7426371	Murdering Lagoon monitoring
3	Lagoon Creek, final SRD discharge	LCSCD	449480.3	7444277	For conditions after exiting the mine site
4	Lagoon Creek downstream	LCD	450868	7440441	For conditions after point of discharge from the final SRD
Sandy Creek					
5	Sandy Creek upstream	SCU	440745.8	7438237	For conditions prior to entering the mine site
Rocky Creek					
6	Rocky Creek Upstream	RCU	442215.1	7444155	For conditions prior to entering the mine site
Little Sandy Creek					
7	Little Sandy Creek upstream	LSCU	442378.4	7443298	For conditions prior to entering the mine site
8	Little Sandy Creek upstream	LSCRCD	445276.3	7445135	For conditions of LSC and RC after exiting the mine site
Spring Creek					
9	Spring Creek upstream	SPU	438988.9	7424345	For conditions prior to entering the mine site

The monitoring locations outlined Table 9.6 ensure spatially independent data sets as they:

- minimise the risks of falsely detecting a disturbance or environmental impact when one has not occurred
- minimise the risk of missing an environmental impact, if it has occurred
- assist with identification of the source in the case of an environmental incident
- detect differences or changes that are environmentally important.

9.2.3 Measurement parameters

The relevant parameters for the on–going monitoring program will be derived from the results of the baseline monitoring program and used for the on–going water quality monitoring from a yet to be negotiated date. However parameters relevant to coal mine activities have been identified and are listed in the Table 9.7.

As per the baseline monitoring program, the selection of parameters was based on the report '*A study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin*' published by the Queensland Government in 2009.

It is anticipated that there will be no need to monitor for certain individual parameters and they would be removed from the Table 9.7 below. Pesticides have already been removed as not typically associated with mine coal activities, however these parameters will need to be added if found in notable concentrations during the baseline monitoring.

9.2.4 Water quality monitoring schedule

The water quality monitoring schedule should be re–defined in concurrence with the parameters identified from the background monitoring program. Table 9.7 provides an interim monitoring schedule. Details of sample collection (for example rising/falling stage automated samplers, probe with data logger, grab samples) to be used for each of the parameters listed in the Table 9.7 will ultimately be at the discretion of the competent person undertaking the sampling, as long as sampling and monitoring is in compliance with requirements of the DERM Monitoring and Sampling Manual 2009 and ANZECC (2000) guidelines.

Table 9.7 Water quality monitoring schedule

Monitoring sample type	Water quality parameter		Sample frequency
Fully automated sampling stations	pH Temperature EC Turbidity DO TSS Sulphate		At least daily when flow is detected and during release. During release, the first sample must be taken within two hours of the commencement of release.
Event Sampling	Matrix: Water	Matrix: Sediment	During and after major rainfall and flow events. AND At the commencement of release and thereafter weekly during release.
	Electrical conductivity pH TSS Turbidity TN TP Chlorophyll a Acidity Alkalinity as $CaCO_3$ Major cation and anions TPH ***Metals (total and dissolved):*** Aluminium (Al) Arsenic (As) Boron (B) Cadmium (Cd) Copper (Cu) Cobalt (Co) Chromium (Cr) Iron (Fe) Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Uranium	Electrical conductivity Acidity Alkalinity as $CaCO_3$ Moisture Particles sizing ***Metals (total for particles <63 µm and >63 µm and dissolved):*** Aluminium Arsenic (As) Boron Cadmium (Cd) Copper (Cu) Cobalt Chromium (Cr) Iron Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Uranium Vanadium Manganese (Mn)	

Monitoring sample type	Water quality parameter		Sample frequency
	Vanadium (Va) Manganese (Mn)		

9.3 Sampling requirements

Sampling requirements based on ANZECC (2000) guidelines are outlined below. The requirements stand for both the baseline monitoring and the on–going monitoring.

The sampling sites must have safe access under all conditions.

- The sites should be identified by use of a GPS, and the location of any routine sampling should also be mapped and recorded by GPS.
- All samples taken during sampling or field measurements need to be recorded including minimum number of samples taken, sample identification numbers, date, time, site number, sampler, site conditions, instrument calibration data and incidents or damage. All field records must be completed before leaving a sampling site.
- Procedures for collecting, labelling, transporting and storing samples and necessary ancillary field data specific to each matrix and constituent must be in accordance with the Australian Standard 5667.6 (1998), Australian Standard 5667.12:(1999) and DERM Monitoring and Sampling Manual 2009.

9.3.1 Quality assurance quality control

A data validation process is to be used to assess the effect of the site–sampling program on the data quality. The data quality assessment should be based upon requirements of the DERM Monitoring and Sampling Manual 2009.

10. Conclusion

The purpose of this report was to describe the existing environment for water resources that may be affected by the Project Mining Lease Application (MLA) area in the context of environmental values as defined in such documents as the *Environmental Protection Act 1994* (EP Act), Environmental Protection (Water) Policy 2009 (EPP (Water)), Australian New Zealand Environment and Conservation Council (ANZECC) 2000, and the Queensland Water Quality Guidelines (QWQG).

Five key watercourses have been identified within the Project area, with all other streams located being tributaries of these key watercourses. No site specific Environmental Values were available for the Project area, so the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines were used to determine the ecosystem condition of the waterbodies and establish trigger values. It was determined that the most appropriate classification for the stream in the MLA area under the ANZECC guideline is a 'slightly to moderately disturbed (SMD) system'. However because the watercourses are ephemeral and the water quality differs under this type of flow regime, the Queensland Water Quality (QWQ) guidelines recommend the development of local separate guidelines rather than applying the default ANZECC values. However, limited available historical and site specific data on surface water quality was available to derive local values. In addition, the available site specific data quantity and sampling rationale does not allow for conclusive assessment of the condition of the watercourses and hence provides only indicative water and sediment quality characteristics, rather than representative data of the watercourses.

Consequently, a baseline monitoring program is provided in this report and should be implemented as soon as practicable, to collect reference data and background data. In the meantime, interim release contaminant limits are provided based on ANZECC guidelines and historical data. It is expected that more relevant trigger limits will be derived from the results of the baseline monitoring program.

Identified potential impacts on water quality associated with construction and operational activities in the Project area are associated with vegetation clearing, creek diversions, and drainage of structures. Other impacts arising from the mine activities may result in increased erosion and sedimentation, pollutants contaminating waterbodies, additional surface water, increased weed infestation, and discharge of metals and trace elements into ground and surface waters.

Mitigation measures recommended relate to the implementation, monitoring and auditing of a Water Management Plan (WMP), an Erosion and Sediment Control Management Plan (ESCP), and an Environmental Management System, and the effective the management of water generated by the Project including water received as rainfall and/or water from underground seepage via the site water management system.

The implementation of the water quality monitoring programs detailed in this report should enable effective planning and control of discharges into the receiving watercourse. It also should allow for performance review of the various mitigation measures and plans implemented to protect the integrity of the waterbodies. The program is designed to demonstrate that the mine's operations on the Project area are not creating unacceptable environmental effects on surrounding watercourses and receiving waters, including stream ecological and physical process.

The on–going monitoring program will be revised once the results of the baseline monitoring program are available to ensure on–going monitoring using suitable site specific parameters.

11. Residual impacts

Based on the recommended monitoring programs and mitigations measures given above, the residual impacts from the Project are predicted to be limited.

The baseline monitoring program and resulting data as given in Section 9.1, should enable the establishment of suitable site specific parameters to be applied to the Project's Environmental Authority to enable the detection of any potential impacts on water quality and sediment which may occur across the mine site.

12. References

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